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A STUDY OF SOCIAL FACILITATION DURING PROGRAMMED INSTRUCTION. FINAL REPORT.

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THIS STUDY INVESTIGATES THE POTENTIALLY FACILITATIVE AND INHIBITORY EFFECTS OF SOCIAL INTERACTION DURING PROGRAMED INSTRUCTION. SPECIFIC OBJECTIVES WERE (1) TO IDENTIFY THE PARTICULAR ASPECTS OF SOCIAL INTERACTION CRITICAL TO FACILITATING OR INHIBITING PROGRAMED LEARNING, AND (2) TO DETERMINE THE METHOD OF CONSTRUCTING WORK GROUPS THAT OPTIMIZES LEARNING FOR BOTH LOW AND HIGH ABILITY STUDENTS. ONE HUNDRED AND EIGHTY ELEVENTH-GRADE STUDENTS COMPLETED A 660-FRAME LINEAR PROGRAM, WORKING EITHER INDIVIDUALLY OR IN A GROUP OF FOUR CLASSMATES HOMOGENEOUS OR HETEROGENEOUS IN ABILITY. GROUPS OF EACH TYPE WORKED UNDER ONE OF THREE CONDITIONS THAT PROVIDED FOR INCREASING DEGREES OF SOCIAL INTERACTION--(1) GROUP PACING, (2) GROUP PACING AND PUBLIC KNOWLEDGE OF RESULTS, AND (3) GROUP PACING, PUBLIC KNOWLEDGE OF RESULTS, AND GROUP DISCUSSION. DEPENDENT MEASURES INCLUDED ERROR RATE, COMPLETION TIME, IMMEDIATE AND DELAYED CRITERION-TEST SCORES, AND STUDENT ATTITUDE TOWARD THE CONTENT AND METHOD OF INSTRUCTION. THE ONLY OBSERVED DIFFERENTIAL EFFECT OF SOCIAL INTERACTION WAS IN PROGRAM COMPLETION TIME WHICH TENDED TO INCREASE AS THE DEGREE OF INTERACTION INCREASED. LEARNING EFFICIENCY WAS GREATEST FOR STUDENTS WHO WORKED AS INDIVIDUALS. HOMOGENEOUS AND HETEROGENEOUS GROUPS DID NOT DIFFER FROM EACH OTHER ON ANY DEPENDENT MEASURE. THUS, THE ADMINISTRATION OF PROGRAMS TO INTERACTING GROUPS IMPEDED LEARNING EFFICIENCY WITHOUT AFFECTING ACHIEVEMENT OR ATTITUDE. (HM)

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February 1967

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Gerard C. Kress, Jr.

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INTRODUCTION

The major portion of the research literature of programmed instruction describes a sustained effort to distinguish between the critical and the non-critical features of learning that has been successfully programmed. Skinner's original model (23) has been modified along a number of dimensions, often without measurable diminution in the effectiveness of the learning experience. For example, it is now widely held that machine-mediation of the program source is not crucial for most objectives (9, 24). Also, it has been shown that learning may be programmed without the one-to-one match of student and program source with individual pace-selection that was characteristic of the original model (1, 2, 6, 7, 16, 17, 22). Programs have been successfully administered in booklets, slides, films and television. Students have taken programs both in isolation and in the presence of other students. The pace at which they worked has been both self-adopted and externally imposed. Each of these administrative modifications has been shown to be possible without any necessary sacrifice in student achievement. All of this leads to the conclusion that the general method is quite adaptable and that programmed instruction may be considered in a variety of administrative contexts.

One feature of the programmed instructional setting which, until recently, has remained constant throughout the many modifications has been the relative isolation of the individual student with a program. Single source programs have been administered to groups of students at a fixed pace, but the privacy of each student's interaction with the program has been maintained. This isolation, which represents a reversal from the traditional classroom situation, has the great advantage of providing for the active engagement of every individual in goal-oriented behavior (the goal being specified by the lesson objectives). Despite the highly directive nature of a program, there is some evidence that certain individuals fail to respond to the accompanying isolation in a manner which is consistent with achievement of the goal.

A study by Kress and Gropper (15) revealed that a sizable number of eighth-grade students, when presented with individual program sources and allowed to pace themselves, persistently displayed a pattern of high error rates coupled with rapid work rates. Such patterns were followed by relatively low scores on the criterion test. Similar patterns were observed by Kress (14) among sixth graders. The tendency for perseveration of errors while working rapidly implied that these students were not sufficiently responsive to their inaccuracies as revealed to them by confirmation frames. In these studies, it was concluded that this non-adaptive pattern of performance may be attributed to either poorly developed work habits or lack of motivation. Whatever the explanation may be, the performance of these students calls into question the efficacy of permitting students to work independently in a situation which requires certain minimal self-study skills they may not possess.

It is also possible that some students, particularly younger students, are not amenable to working intensively in relative isolation from others. The material itself does not always overcome this problem as is indicated by the objections which students sometimes report to programmed instruction. Students questioned by Gagné and Dick (8), for example, objected to the lack of interaction with other humans and to the boredom that they experienced from prolonged exposure to programs. Similar reactions are reported by Gotkin (11). While such comments may not be related to immediate success or failure, they are reported often enough to cause concern about maintaining high levels of motivation over long periods of time. Several recent studies have responded to this particular concern by investigating the effects of departing from another aspect of Skinner's original model, the private interaction of individual with program source.

Programmed Instruction Administered to Interacting Groups

Frye (7) administered programs to groups constituted so as to be either academically heterogeneous or homogeneous. Each student was permitted to respond privately, but the pace of instruction was group determined. Each new frame was presented to the group after the slowest member had finished the previous frame. The homogeneous groups required no more time to complete the program than students who worked as individuals. The heterogeneous groups, on the other hand, required more time to complete the program. Frye concluded that the superior efficiency of the homogeneous groups may have resulted from more favorable conditions for competition among them than was the case among the heterogeneous groups.

Dick (4), and Dick and Seguin (5) went beyond group-determined pacing and permitted additional interaction. They assigned programs to pairs of college students who worked through the program, together, as teams. Thus, they worked at a jointly determined pace and, in addition, were free to discuss the material as they went along. The paired students required significantly more time to complete the program but no reliable changes were noted in individual achievement as a result of pairing. Dick (4) reports that many students expressed a post-experimental preference for working with a person of "equal ability." These expressions are consistent with Frye's suggestion that like-ability grouping may facilitate social interaction during the program.

A somewhat different administrative strategy was employed by Parry (19) in an effort to control cheating behavior during programs. To prevent students from looking ahead to the confirmation panel before responding to the frame, he presented the program on a large flip-chart. The chart, placed before a class of students, served as a large programmed booklet through which the class worked at a group pace. When everyone in the class had finished a frame, the teacher turned to the confirmation page and then to the next frame. The group setting produced gain scores twice as large as those resulting from individual study with programmed booklets. Further, the flip-chart group required no more time than the group that worked in booklets because ". . . they worked at a fever pitch with intense concentration," whereas, students who worked in isolation ". . . were inclined to let their attention wander whenever the going got rough." Parry concludes that the marked superiority of the flip-chart method resulted from heightened attention to the task and the social reinforcement derived from experiencing correctness as a group.

Crist (3) describes an experiment in which four academically superior seventh graders worked through a vocabulary program under both group and individual conditions. They alternated between working individually, with programmed booklets, and together, with frames presented via an overhead projector. During the group sessions, students took turns answering out loud before the correct answer was unmasked. The mean posttest score of the four subjects on the units studied under group conditions was significantly higher than on the units studied in isolation. Not only was achievement higher from the group setting; the students found it less boring and tiresome than reading the programmed texts at their own desks. Crist concludes that the reinforcing effects of the social situation are sufficiently great to justify more widespread group administration of programs as a means of maintaining long-term participation in programmed learning. Like Parry, he describes long-term administrative and motivational advantages accruing from group practice in addition to enhanced retention of lesson objectives.

A somewhat more detailed investigation of social interaction during programs was conducted by Paulson (20) who studied the performance of average-ability students. He used a factorial design to assess the effects of public as opposed to private confirmation of answers with groups constituted so as to be either homogeneous or heterogeneous in intelligence. He found that the private confirmation procedure restricted discussion and significantly lowered achievement scores of average students. He attributes the superiority of the public confirmation procedure to the "intensified" reinforcement that accompanies knowledge of one's results relative to the group. He also found that working in homogeneous groups led to higher achievement among average-ability students than did working with bright students. Paulson accounts for this by hypothesizing that the lower-ability students had greater "access" to reinforcement (degree of perceived success relative to the group) when they worked in groups comprised of other lower-ability students. No results are presented to describe the effects of these variables on the higher-ability students.

Taken together, this set of studies indicates that individual pacing and privacy may not be essential for effective programmed learning. Furthermore, the results obtained by Crist (3), Parry (19), and Paulson (20) lead to speculation that social interaction may actually facilitate programmed learning. It would appear that administering programs to interacting groups may obviate two of the major objections that have arisen to programmed instruction. The first objection, mentioned earlier, is that students report boredom after prolonged individual exposure to programmed lessons. The second objection is that individualized learning presents very real administrative problems when students begin to progress at different rates. Variable rates of progress are difficult to deal with in the framework of traditional classroom grouping arrangements. In addition, it appears that social interaction may help to overcome the kinds of innappropriate student performance characteristics reported in earlier studies (14, 15). For example, Parry and Crist both found achievement from group administration to be superior to that from individual administration.

The Conditions for Social Interaction Effects on Programmed Learning

If social interaction affects learning from programs, then the particular conditions for its effects--both facilitative and inhibitory--must be specified. Two considerations appear especially crucial: (1) the nature or degree of social interaction permitted during the program, and (2) the method by which the interacting groups are constituted.

Types of interaction. Several distinct types of interaction can be identified, each representing a distinctly different modification from the situation of individuals working in private. One modification is introduced by requiring members to work at a group-determined pace, i.e., by presenting confirmation frames only after the slowest responder has finished. Individual selection of a working pace is therefore sacrificed for all but one group member during each frame. This procedure is likely to force the faster students in the group to work at the pace of the slower students. It may also force slower workers to work faster than they would in isolation so as not to hold back the group.

If public knowledge of results is added to group pacing, then the situation permits mutual awareness of both pace and accuracy of performance. When responses are made public, the reinforcing aspects of confirmation--positive and negative--may be augmented by knowledge of one's success relative to the group. Finally, when discussion is permitted among group members, the opportunity exists for additional facilitative or inhibitory effects. For example, if an effective discussion occurs which assists an errant member of the group to right a misconception, then improvement might be expected in his subsequent performance. If, on the other hand, conflict or otherwise distracting behavior occurs, a disruption of the learning process might be expected.

It thus appears that the public rather than the usual private administration of a program contains the ingredients for impeding or improving performance. Further, it is apparent that social interaction as defined in previous studies is not a unidimensional variable. In most of them, several types of interaction were permitted to occur simultaneously. In order to account for the effects of social interaction on programmed learning, each type must be evaluated separately.

Constitution of the interacting groups. In view of the wide ranges of learning rates, ability, and backgrounds which are typical within a given grade level, it is possible to group students so as to create varying degrees of homogeneity within groups. The performance of the very capable student when working with equally capable students is likely to be different from that when working with less capable students. The extent to which group members are similar or dissimilar in ability would appear to be an important determinant of the effects of social interaction. For example, Dick (4) observed a reported preference among his students to work with a person of "equal ability." Paulson (20) attributes the higher test scores of lower-ability students who worked in homogeneous groups to the fact that they had greater "access" to reinforcement than those who worked with brighter students. Group similarity may be expected to affect disparities in pacing, degree of perceived success relative to the group, and the patterns of inter-student "tutoring" behavior that are likely to emerge from interacting groups. Generally, then, both the ability level of the individuals and the degree of similarity in ability within groups appear to be crucial determinants of both interaction and learning during such group instruction.

Purpose

The general purpose of this study was to investigate the potentially facilitative or inhibitory effects which result from the introduction of social interaction into the programmed instructional setting under a wider range of conditions than has previously been considered. Comparisons were made between high- and low-ability students working either in isolation or in one of three group settings which provided increasing degrees of opportunity for interaction to occur, from simple sharing of a group pace to public knowledge of results as well, plus freedom to discuss the material at length. Under each of the three conditions of interaction, work groups were constituted so as to be either homogeneous or heterogeneous in ability.

By observing the performance of a control group working as individuals, it was possible to specify a baseline against which the performance of the various interacting groups could be compared. This baseline made it possible to describe each effect as either facilitative or inhibitory. The isolation of three increasing degrees of opportunity for social interaction made it possible to identify the contribution of each type to performance changes. The systematic control of group homogeneity/heterogeneity provided an estimate of the effects of contrasting group-formation strategies on both low-and high-ability students.

METHOD

Subjects

The 180 Ss who participated in this study were eleventh-grade volunteers drawn from three Pittsburgh high schools. Samples of 64 and 58 Ss were drawn from two public schools; another sample of 58 Ss was drawn from a parochial school. Since it was decided that all working groups should consist of classmates, the basic experiment was replicated at each of the three schools. Each S was paid an honorarium of $15.00 at the conclusion of the experiment.

Materials

The lesson materials employed in the present study consisted of the first 11 chapters of Atomic Physics by Klaus and Deterline (13). Each chapter was bound into a programmed booklet. These 11 chapters, containing 660 frames, cover one portion of a programmed course in high school physics. The program is linear, requiring constructed responses, and uses the "vanishing" technique whereby cue support is gradually reduced and responses become longer and more complex. An excerpt from each chapter is presented in Appendix A.

The criterion tests employed in this study consisted of two sections: a proficiency test and a transfer test. The proficiency test, containing two items from each chapter, was designed to measure direct achievement from the program. The transfer test, which also contains two items from each chapter, was designed to measure application of principles in contexts that differed somewhat from those appearing in the program. Both were developed by Klaus for use in a previous study (12). The tests are presented in Appendix A.

Student attitudes were measured both before and after the experiment by a semantic-differential style questionnaire (18) similar to that employed by Paulson (20). It consists of six sets of rating scales, three of which required Ss to respond to methods of instruction and three of which dealt with the content of the lessons. The use of these scales made it possible to quantify student reactions toward both aspects of instruction and to note changes in attitude as a result of the experiment. The scales are presented in Appendix A.

Experimental Design

Independent variables. The purpose of this experiment was to assess the effects, for both low-and high-ability students, of varying degrees of social interaction during programmed instruction. Among those students who worked in interacting groups, comparisons also were made to assess the effects of homogeneous as opposed to heterogeneous grouping. The design employed to accomplish the desired comparisons is shown in Fig. 1. In order to insure that work groups would not be composed of total strangers, the basic experiment was replicated at each of the three schools.

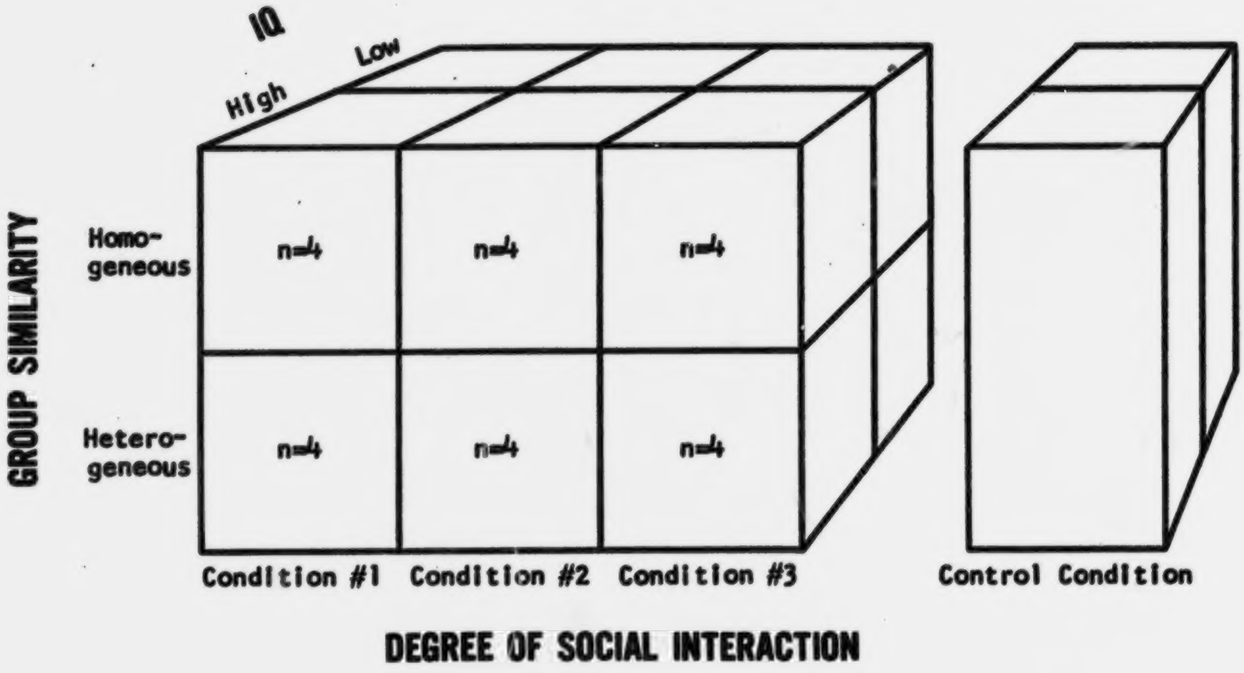

Fig. 1. Design of the study. This design was used at each of the three schools sampled.

Assignment of classmates to treatments within each school was accomplished as follows: first, the subject pool was evenly divided into high-and low-ability levels on the basis of Otis IQ scores; within each ability level, Ss were randomly designated as homogeneous or heterogeneous; students of each designation were then randomly assigned to one of the three types of interacting groups until each of the cells was filled with four Ss. The remainder were then assigned to the control group. This procedure permitted assessment of varying degrees of interaction for high-and low-ability Ss by treating 3 Schools, 4 Degrees of Interaction (including the control condition) and 2 levels of Ability (collapsing homogeneously and heterogeneously grouped Ss) as independent variables. Assessment of Group formation strategies was accomplished by considering only the Ss who worked in groups (excluding control Ss) and treating 3 Schools, 3 Degrees of Interaction, 2 levels of Ability, and 2 Group Formation strategies, homogeneous and heterogeneous, as independent variables.

Students assigned to the Control Group worked in a room with other control *Ss*, but individually, each at his own pace, and with no communication with other *Ss*. Students assigned to the four-man work groups worked under one of three conditions of interaction. Condition #1 *Ss* worked at a pace determined by the slowest member of their work group, but were not allowed to communicate with other members of their work group. Condition #2 *Ss* worked at a similar group pace, but also read their answers for each frame out loud. Condition #3 *Ss* worked at a group pace, read their answers out loud, and were allowed to discuss their answers with other members of their work group. Working groups were constituted of either 4 high-IQ *Ss* (homogeneous, high-ability), 4 low-IQ *Ss* (homogeneous, low-ability), or 2 low-and 2 high-ability *Ss* (heterogeneous).

Dependent variables. The dependent variables in the present experiment included measures of the following: (1) error rates during the program, (2) completion times, (3) scores on criterion tests given immediately after completion of the program and one week later, (4) attitude scores and (5) patterns of interaction occurring among members of groups that were permitted discussion during the lesson.

Procedure

The procedure followed at each school consisted of three phases: (1) a preliminary session, (2) four experimental sessions, and (3) a retention-testing session.

Preliminary session. All *Ss* who volunteered to participate met one week prior to the experiment for a general briefing. During this session, Otis Gamma IQ Tests and Pretests consisting only of the proficiency items, were administered to all students. The IQ scores were used to assign *Ss* to treatment groups. When assignments were completed, *Ss* were notified when to report for experimental sessions.

Experimental sessions. Four consecutive, half-day experimental sessions were conducted for each work group and the control group. Each four-man group worked in a separate room with one *E* present to monitor the session. Control *Ss* worked in a room, together, seated in regular classroom fashion with one or two *Es* as monitors. Each *E* was instructed to insure that only the degree of interaction specified by each condition occurred, and to record completion times.

In addition to their other duties, the crew of six *Es* who monitored experimental sessions were required to maintain continuous records of discussion responses that occurred under Interaction Condition #3. Following some trial and revision sessions prior to experiments, a three-category system was specified. Forms were designed on which each S's discussion responses on a particular frame were designated as "S," "P," or "C."

An "S" was recorded if the response sought information from teammates relative to the lesson content. For example, if one S said: "How do you remember whether protons are positively or negatively charged?", an "S" would be recorded adjacent to that S's name on the recording form.

The second classification category, "P," was used when a response provided information about the lesson content. A "P" would be recorded, for example, if an S said: "Well, 'proton' starts with the letter 'P' and so does 'positive,' and protons are positive!"

The third category, scored as "C", was employed for any discussion response that neither sought nor provided content-relevant information. All comments about the method of instruction, the time of day, etc., were scored as "C."

It was initially attempted to classify each of the three types of oral response further with a + or - to designate, respectively, positive or negative affect. However, during trial sessions used to train Es in the use of the scoring system, it became evident that inter-scorer reliability was so low as to render affect judgments virtually useless. The + and - designations were therefore dropped and Es participated in several trial exercises until their three-category ratings became quite reliable.

Eventually, every E was assigned in counter-balanced fashion to work groups under all three conditions of interaction. Thus, discussion data were contributed by all six Es.

The sequence of tasks for all treatment groups was always the same. On Day One, after E made sure that everyone knew each other, Ss completed the attitude questionnaire, received instructions on how to work during the program, and began to work on the first chapter. They were permitted to work until they completed four chapters or until three hours had elapsed. No group completed more than three chapters during the first session. They continued the program during the next two days, completing two to four chapters per day. During the fourth and final session, all groups worked through Chapter 11 and were given the Immediate Posttest. Following the test, Ss completed the same Attitude Questionnaire they had completed during the preliminary session.

Briefly, the instructions for the subjects in groups under the various experimental treatment conditions were as follows:

(1) Condition #1 *Ss* were instructed to work on a single frame of the program, put their pencils down when they finished the frame, and not continue on to the next frame until all group members were finished. No communication between group members was allowed.

(2) Condition #2 *Ss* were also to work at a group pace, as were Condition #1 *Ss*, but they were also told to read their answers to each frame aloud before continuing to the next frame. No talking beyond reading the answers aloud was permitted.

(3) Condition #3 *Ss* worked at a group pace and read their answers aloud, but were not to proceed to the next frame until every group member was satisfied that he understood the frame. Discussion was restricted to the programmed material; extraneous discussion was discouraged.

(4) Control group *Ss* were told to work at their own pace, spending as much time on each frame as they wished. No talking was permitted among control group *Ss*.

Retention-test session. All *Ss* returned one week following the fourth session and completed the criterion tests again. Upon completion of the tests, they were each paid $15.00 for their participation.

RESULTS

The results of this study can be described in relation to three separate experimental outcomes: (1) the general effects of social interaction; (2) the effects of heterogeneous versus homogeneous group-formation strategies; and (3) the patterns of social interaction that developed in groups that were permitted to discuss the lessons. Each of the three outcomes was assessed by a different set of analyses as described in greater detail in the sections to follow.

A total of 14 of the original sample of 180 Ss failed to complete the experiment, giving rise to unequal cell frequencies. The analyses were limited to those Ss who completed the experiment. In each analysis of variance computation, unequal cell frequencies were corrected by the Method of Unweighted Means (21, 25, 26). While this method is approximate, tending to err in the direction of Type I errors, the disturbance to the five percent level of significance has been shown to be moderate (10).

The General Effects of Social Interaction on Performance

The overall effects of the various forms of social interaction were assessed by treating 3 Schools, 4 Degrees of Interaction, and 2 levels of Ability as independent variables. In these analyses, the Control Condition is included as a baseline or zero-degree of interaction and the heterogeneously and homogeneously grouped Ss within each ability level are pooled. (See Fig. 1.) Analyses of variance performed on IQ, Pretest scores, and pre-experimental Attitude scores indicated that Schools differed significantly in IQ, prior knowledge of atomic physics, and attitude toward programmed instruction. Ability levels differed in prior knowledge. Apart from these School and Ability differences, the various treatment groups were reasonably well equated on the preliminary measures. (These analyses are summarized in Tables 1-B through 5-B in Appendix B.)

The effects of social interaction were measured in terms of criterion test scores, accuracy during the program, time required to complete the program and student attitudes. Tables 1 and 2, which summarize the means of each dependent measure under each condition, provide an overview of the effects of the varying degrees of social interaction on performance. More detailed analysis of variance summaries as well as means and standard deviations for each level of each independent variable are presented in Tables 6-B through 16-B in Appendix B.

Criterion test scores. The criterion test consisted of one section designed to measure proficiency and one section designed to measure transfer. The proficiency section was administered as a pretest. Both sections were administered immediately upon completion of the program and, again, after a delay of one week. A separate analysis was performed on the scores obtained from each administration of each section. All five measures are summarized in Table 1. On the average, proficiency score rose from a pretest level of less than 23% to over 83%. The one-week delay resulted in only a one-point drop in average proficiency, to 82%. Average score on the Transfer Test was lower: just under 61%. On the delayed test, average Transfer score rose slightly to 61.4%. With respect to differences among the four treatment conditions, no significant difference occurred on any of the criterion test scores. Criterion test performance was highly similar across all treatment conditions.

Table 1

Criterion Test Means Across
Administrative Conditions
(Percentage Scores)

	Degree of Social Interaction				
	Control: Individual Administration $\bar{X}$	Condition 1: Group Pacing $\bar{X}$	Condition 2: Group Pacing & Public Confirmation $\bar{X}$	Condition 3: Group Pacing & Public Confirmation & Discussion $\bar{X}$	SIGN. LEVEL
Pretest (Proficiency)	20.5	25.6	22.6	20.7	N.S.
Immediate Proficiency Test	82.2	84.2	83.7	83.7	N.S.
Immediate Transfer Test	59.8	60.1	62.3	60.4	N.S.
Delayed Proficiency Test	80.7	83.4	82.6	80.9	N.S.
Delayed Transfer Test	60.6	61.0	64.0	60.9	N.S.

School and Ability led to significant differences on all four criterion test scores (see Tables 6-B and 9-B, Appendix B). Highest scores were obtained at the school that had demonstrated the highest IQ and Pretest scores during preliminary sessions. Not surprisingly, high-ability Ss obtained higher criterion test scores than low-ability Ss.

Only one statistically significant interaction occurred among the independent variables. That interaction, between Degree of Social Interaction and Ability on Delayed Transfer scores, is displayed in Fig. 2. It reveals a modest tendency for scores of high-IQ Ss to decline as a result of social interaction while scores of low-IQ Ss tended to rise. The smallest difference between ability levels occurred under Condition #2. However, this trend was not present on any other performance measure.

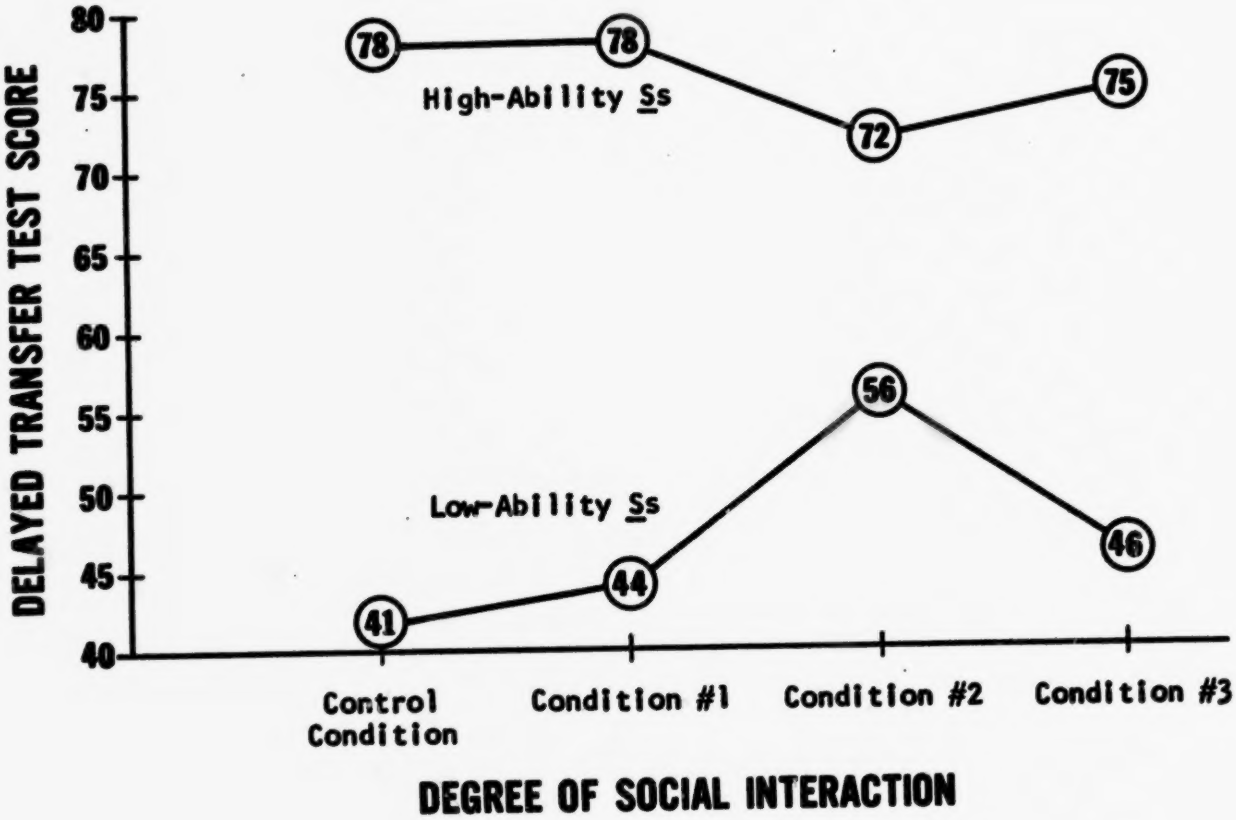

Fig. 2. Interaction between Degree of Social Interaction and Ability that occurred on Delayed Transfer Test scores.

Accuracy during the program. Program accuracy was assessed by analysis of the variance of error rates. Error rate was defined as the total number of incorrect responses divided by the number of separate responses called for in the program. Error rates ranged between 4.7% for high-IQ Ss and 12.7% for low-IQ Ss, with the average error rate at 8.7%. From Table 2, it may be seen that, as was the case for criterion test scores, Ss under all four conditions of social interaction performed at very similar levels.

School and Ability both produced significant differences in error rate which were consistent with those observed for criterion test scores. (See Tables 12-B and 13-B, Appendix B.) There were no significant interactions among the independent variables on error rates.

Table 2

Program Accuracy, Completion Time, and Attitude Scores Across Administrative Conditions

	Degree of Social Interaction				
	Control: Individual Administration	Condition 1: Group Pacing	Condition 2: Group Pacing & Public Confirmation	Condition 3: Group Pacing & Public Confirmation & Discussion	SIGN. LEVEL
	$\bar{X}$	$\bar{X}$	$\bar{X}$	$\bar{X}$	
Error Rate (Percent)	8.2	9.4	7.6	8.2	N.S.
Completion Time (Minutes)	281	330	381	438	$P < .01$
Pre-Experimental Content Attitude	14.7	15.4	14.8	18.2	N.S.
Pre-Experimental Method Attitude	41.2	39.5	42.8	38.6	N.S.
Post-Experimental Content Attitude	44.9	41.2	40.6	38.8	N.S.
Post-Experimental Method Attitude	45.5	48.7	55.0	45.8	N.S.

Completion time. The completion-time requirements of the various treatment groups are also summarized in Table 2. As may be seen more clearly in Fig. 3, a progression is evident from the Control Condition to Interaction Condition #3: with each increment in degree of permissable interaction, the time required to complete the program increased. The significance of differences between means was assessed by independent-group t-tests. As indicated in Fig. 3, the differences between Condition #1 and #2 and Conditions #2 and #3 approach, but do not reach significance at the .05 level. However, all other differences are significant beyond the .01 level. All three social-interaction conditions required significantly more time for completion of the program than was required under the control condition where Ss worked alone.

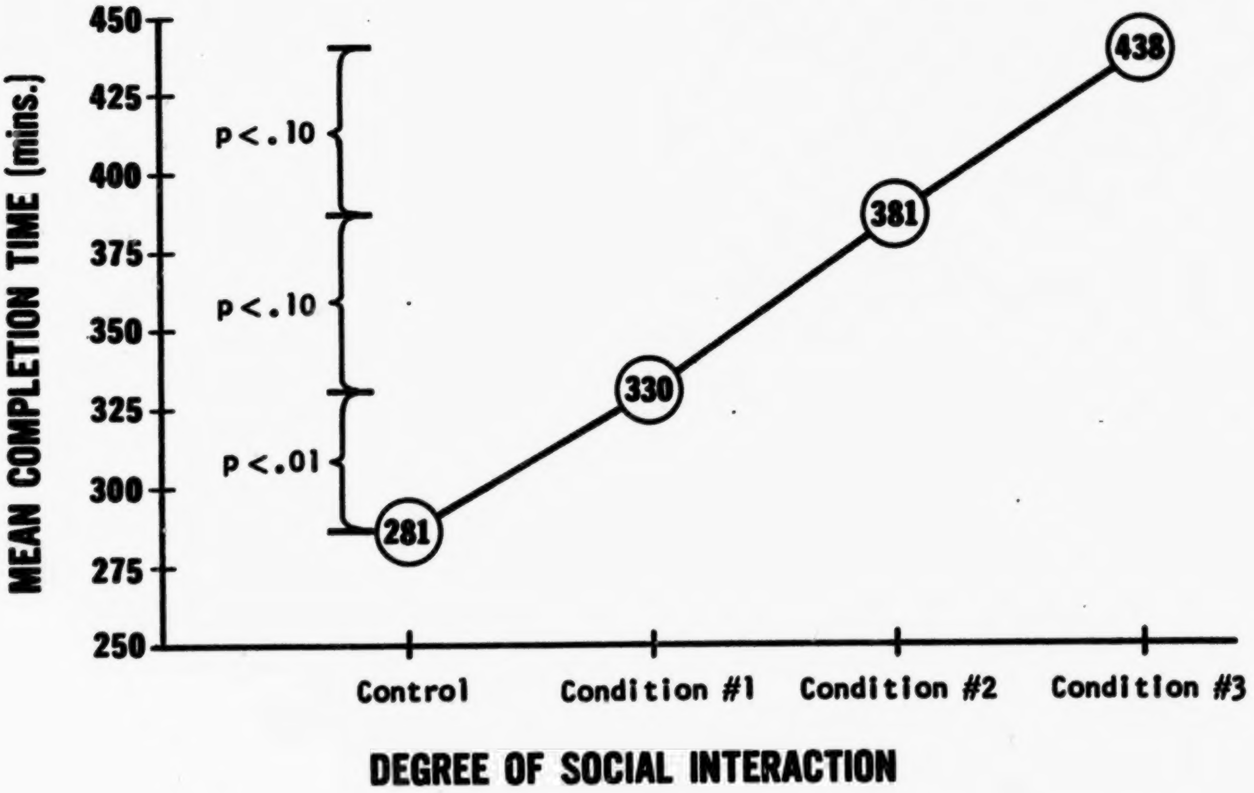

Fig. 3. Time required to complete the Atomic Physics Program as a function of the Degree of Social Interaction during the program.

Student attitudes. Student attitudes were measured, both before and after the experiment, by three items that referred to the content of the Atomic Physics Program and three items that referred to the method of instruction experienced. These ratings are summarized in Table 2. The highest and lowest possible ratings that could arise from the seven-point scoring system were +90 and -90, respectively. Attitude scores, like criterion test scores, were higher after the experiment than they were before it. Student ratings of program content underwent a particularly sharp rise, from +16 to +41. Attitude toward method of instruction rose more modestly, from +40 to +49.

Analyses of variance of both sets of attitude ratings revealed that only Schools led to significant differential effects. (See Tables 14-B through 16-B, Appendix B.) Oddly enough, the school that produced the lowest performance scores produced the highest attitude ratings and vice versa. Apart from School differences, attitudes were rather uniform across all four conditions of program administration and both ability levels. Moreover, there were no significant interactions among the independent variables.

Summary. Considering the results as a whole, the interruption of individual privacy by the introduction of varying degrees of opportunity for social interaction appeared to affect only completion time. Other performance measures, including immediate acquisition, retention, and program accuracy were remarkably similar across all conditions. Likewise, student attitudes both toward the method and content of instruction were very nearly identical across conditions. The one clear effect of social interaction was to increase the time required for program completion.

Heterogeneous Versus Homogeneous Grouping Strategies

The effects of heterogeneous versus homogeneous grouping strategies were assessed by excluding the Control Condition and treating 3 Schools, 3 Degrees of Interaction, 2 levels of Ability, and 2 levels of Group Similarity as independent variables. (See Fig. 1.) For purposes of clarity, the detailed analysis of variance summaries as well as means and standard deviations for each level of each independent variable are again presented in Appendix B (see Tables 17-B through 27-B).

Criterion test scores. The performance of homogeneous and heterogeneous work groups on criterion tests are summarized in Table 3. While homogeneous groups tended to achieve slightly higher scores on every test, none of the differences approach statistical significance.

Table 3

Percentage Criterion Test and Program Accuracy Scores of Homogeneous and Heterogeneous Groups

	Homogeneous Grouping		Heterogeneous Grouping		Sign. Level
	$\bar{X}$	S.D.	$\bar{X}$	S.D.	
Pretest (Proficiency)	22.8	18.8	23.1	21.2	N.S.
Immediate Proficiency Test	84.9	13.8	82.2	19.3	N.S.
Immediate Transfer Test	62.3	20.6	59.6	23.1	N.S.
Delayed Proficiency Test	82.6	15.6	81.8	19.0	N.S.
Delayed Transfer Test	62.5	20.4	60.5	23.7	N.S.
Error Rate	8.3	5.4	9.2	9.1	N.S.

Analyses of variance (summarized in Tables 17-B through 22-B, Appendix B) revealed significant School and Ability effects consistent with those obtained when Control Ss were included. One significant interaction occurred, on Immediate Transfer Test scores, between Degree of Social Interaction and Group Similarity. This interaction, shown in Fig. 4, indicates that heterogeneous grouping, while slightly superior under Conditions #1 and #3, was decidely inferior to homogeneous grouping under Condition #2. Since this interactive trend was not apparent in any other performance measure, and was no longer significant after a one-week delay, it may be best described as an isolated and transient effect.

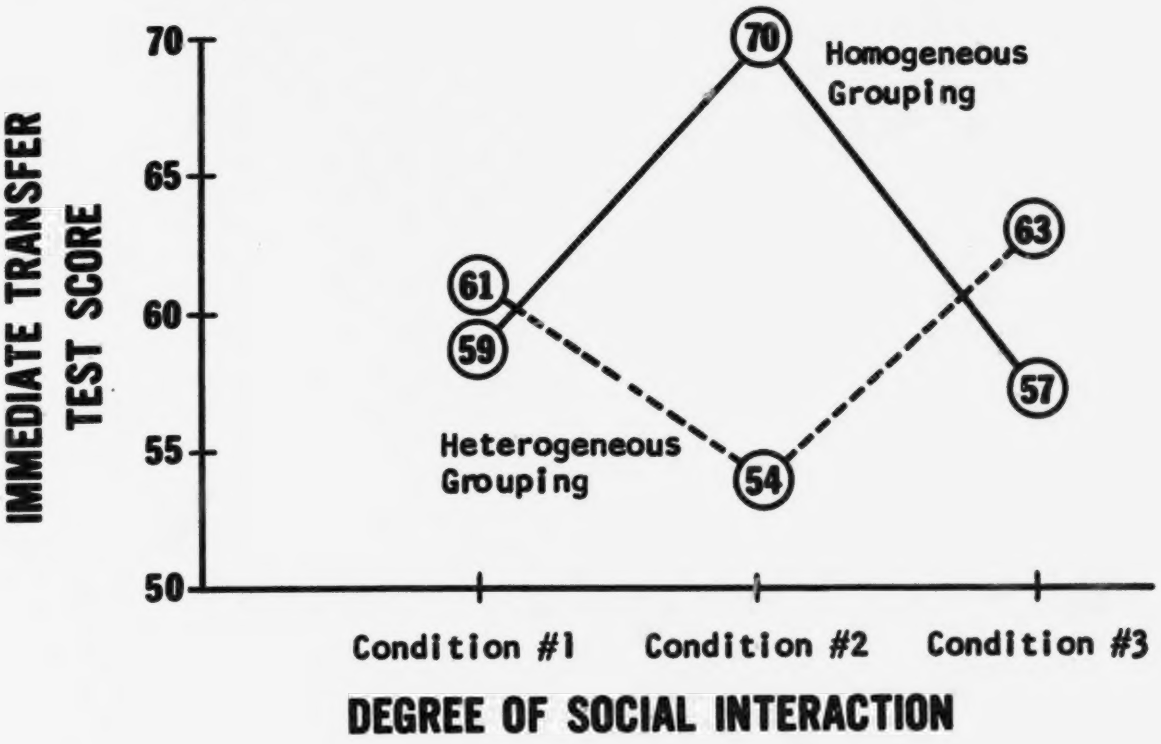

Fig. 4. Interaction between Degree of Social Interaction and Group Similarity that occurred on Immediate Transfer Test scores.

Accuracy during the program. The analysis of error rates (see Table 23-B, Appendix B) revealed that only School and Ability produced significant differences and that there were no significant interactions. As may be seen in Table 3, homogeneous groups were slightly, but not reliably, more accurrate than heterogeneous groups.

Completion time. A detailed summary of completion time requirements is presented in Table 4. Comparisons among means of the various subgroups were made by independent group t-tests.

Overall, homogeneously grouped *Ss* required more time to complete the program than was required by the heterogeneous or mixed-ability groupings. However, this difference was not significant ($t = .53$; $P > .05$) and it was largely due to the fact that low-IQ *Ss* worked much more slowly in homogeneous groups than in heterogeneous groups ($t = 2.36$; $P < .05$). High-IQ *Ss*, on the other hand, worked somewhat faster in homogeneous groups ($t = 1.29$; $P > .05$).

In general, the more able students required less time to complete the program than the less able students. This contrast was clearest between homogeneous high-IQ and homogeneous low-IQ groupings ($t = 2.23$; $P < .05$). When the groups were mixed, the general tendency was toward an averaging of completion time requirements, spending less time than uniformly low-IQ and more time than uniformly high-IQ groupings.

Table 4

Mean Completion Times
of Interacting Groups
(minutes)

		Condition #1	Condition #2	Condition #3	All Conditions		All High IQ
Homogeneous Groups	High IQ	282.0 (n*=3)	341.3 (n=3)	400.7 (n=3)	341.3 (n=9)	390.4 (n=18)	364.1 (n=27)
	Low IQ	407.3 (n=3)	377.3 (n=3)	540.7 (n=3)	439.6 (n=9)		**All Low IQ**
Heterogeneous Groups	(High and Low IQ)	318.7 (n=6)	402.3 (n=6)	405.3 (n=6)		375.4 (n=18)	396.8 (n=27)

*n refers to the number of groups on which the mean is based rather than to the number of individuals.

Student attitudes. Variance analyses of attitude both toward content and methods of instruction (see Table 25-B) indicated that the significant School effects described in the previous section were again evident. There was no significant Group Similarity effect. As shown in Table 5, homogeneous and heterogeneous groups produced highly similar ratings of both content and method. However, the significant Ability by Group Similarity interaction described in Fig. 5 indicates that program content as rated by homogeneously and heterogeneously grouped *Ss* differed as a function of their IQ. High-IQ *Ss* who worked in heterogeneous groups came up with higher content ratings than those who worked in homogeneous groups. On the other hand, the content ratings of low-IQ *Ss* who worked in heterogeneous groups were *lower* than those who worked in homogeneous groups.

Table 5

Attitude Scores of Homogeneous and Heterogeneous Groups

	Homogeneous Grouping		Heterogeneous Grouping		Sign. Level
	$\bar{X}$	S.D.	$\bar{X}$	S.D.	
Pre-Experimental Content Attitude	16.7	19.4	15.6	17.3	N.S.
Pre-Experimental Method Attitude	38.2	27.8	42.2	43.8	N.S.
Post-Experimental Content Attitude	40.7	22.2	39.7	19.0	N.S.
Post-Experimental Method Attitude	49.3	24.2	50.2	25.8	N.S.

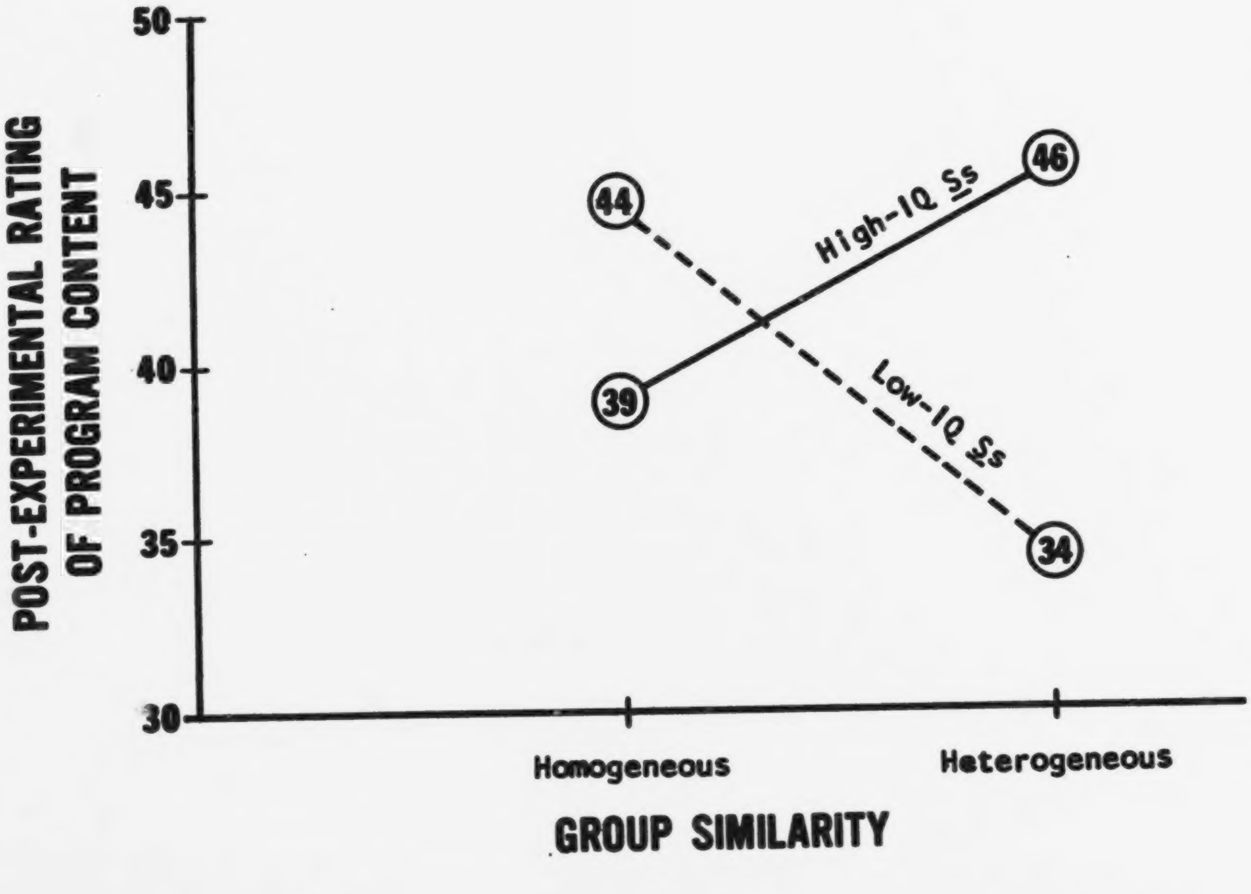

Fig. 5. Interaction between Ability and Group Similarity that occurred on student ratings of the content of the Atomic Physics Program.

Summary. In general, the two group-formation strategies made very little difference in criterion test scores or accuracy during the program. Low-IQ Ss did complete the programs in less time when they were placed in groups containing brighter Ss. On the other hand, this arrangement caused the brighter Ss to spend more time than was required by homogeneously grouped bright Ss. While group-formation strategies had no effect on student attitudes toward the methods of instruction, they did affect attitude toward its content: low-ability Ss rated atomic physics higher when they worked with Ss of their own ability; however, high-ability Ss came up with higher ratings of the subject matter when they worked in groups containing low-ability Ss.

Patterns of Group Discussion

The patterns of social interaction that developed among members of Condition #3 groups were analyzed on three measures: (1) the number of frames during which any S sought information, (2) the number of frames during which any S provided information, and (3) the number of frames during which any form of discussion occurred. Detailed summaries of each analysis are again presented in Appendix B (see Tables 28-B through 31-B). A more general summary of group discussion patterns appears in Table 6.

Information seeking. Inspection of Table 6 reveals rather substantial percentage differences occurred among schools and between ability levels. For example, low-ability Ss sought information during 20.9 of the 660 frames compared to only 12.3 frames for high-ability Ss. However, the variability that occurred in this measure was such that none of the obtained differences was statistically significant at the .05 level.

Information providing. The incidence of information-providing responses was somewhat higher than that of information-seeking responses. (See Table 6.) With respect to information provision, high-ability Ss responded more frequently than low-ability Ss; the brighter Ss provided information during a larger number of frames. However, none of the differences that occurred in this measure were reliable.

Table 6

Mean Discussion Responses
During Condition #3

Levels of Independent Variables		TYPE OF RESPONSE					
		Information Seeking	Sign. Level	Information Providing	Sign. Level	All Discussion	Sign. Level
SCHOOL	A	10.53	N.S.	27.47	N.S.	74.47	P<.01
	B	15.26		23.87		52.87	
	C	22.87		39.50		105.13	
ABILITY	High IQ	12.25	N.S.	34.42	N.S.	70.33	N.S.
	Low IQ	20.86		26.18		86.55	
GROUP SIMILARITY	Homogeneous	15.75	N.S.	31.33	N.S.	83.83	N.S.
	Heterogeneous	17.05		29.55		71.82	

Total discussion. In order to obtain a general measure of the extent to which members of the various work groups interacted, all frames on which Ss commented beyond simply reading their answers were tallied. This measure included both information seeking and providing responses as well as all other comments.

Some form of discussion occurred during an average of 78 of 660 or about 12% of the frames of the program. Schools differed significantly on this measure, from approximately 8% at School B to nearly 16% at School C. (See Table 6.) Low-ability Ss tended to respond more than high-ability Ss and homogeneously grouped Ss tended to respond more than heterogeneously grouped Ss. In neither case was the difference reliable.

The analysis of variance (see Table 28-B, Appendix B) of Total Discussion revealed that the following interactions were significant: School by Group Similarity, Ability by Group Similarity, and School by Ability by Group Similarity. This rather complex set of outcomes is best summarized by inspection of the latter interaction which contains all three variables; it is shown in Fig. 6. It may be seen that the grouping combination that led to the smallest and largest amounts of discussion varied at the three schools. In general, discussion was most frequent among low-ability Ss in homogeneous work groups. However, this trend came largely from School A where those Ss engaged in substantially more discussion than any other grouping combination.

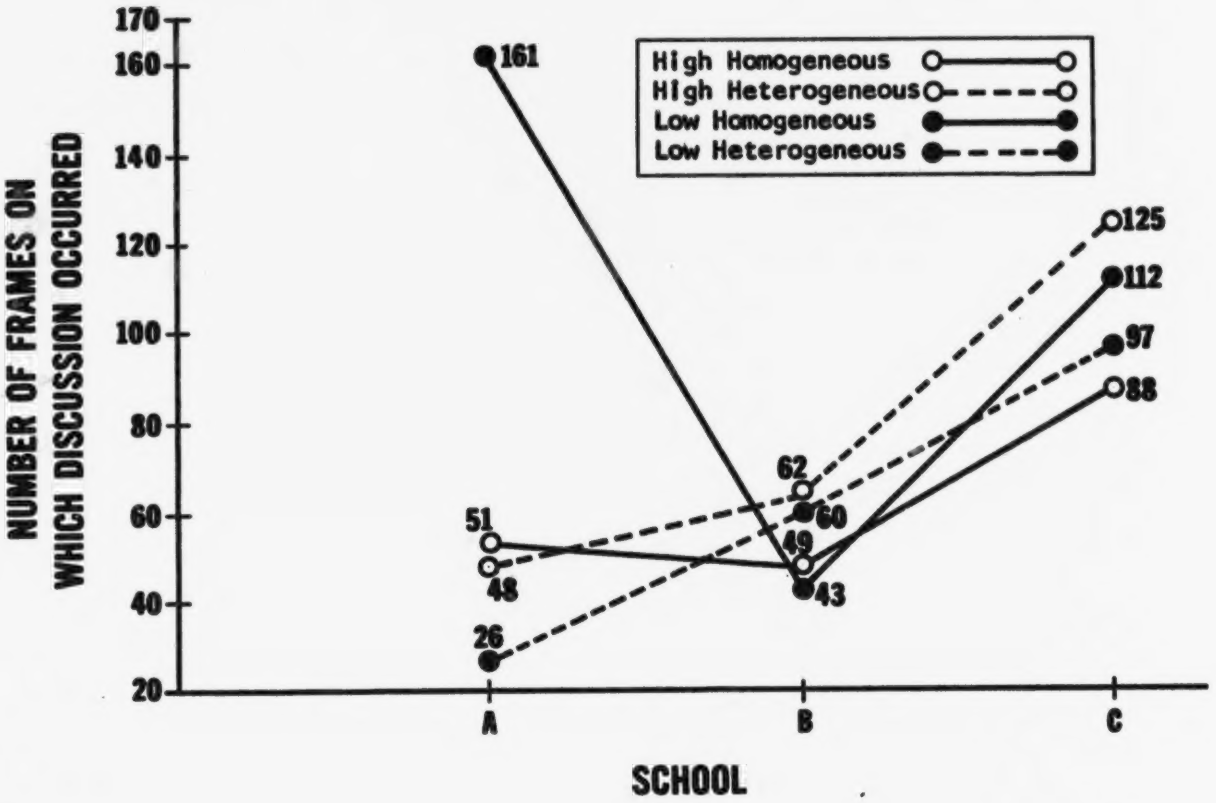

Fig. 6. Three-factor School by Ability by Group Similarity interaction that occurred on the Total Discussion measure under Condition #3.

Summary. Among the groups whose members were permitted to discuss the material after each frame, information was sought after 2.4% of the frames. Information was provided after 4.6% of the frames. Discussion of all types, including comments that neither sought nor provided subject-matter information, occurred after 11.8% of the frames.

Discussion was most frequent at School C where prior knowledge of atomic physics was lowest and student attitudes were generally most favorable. Discussion was least frequent at School A where prior knowledge was highest and attitude ratings were least favorable.

Although neither trend was statistically significant, low-ability Ss tended to seek information more often than high-ability Ss, whereas high-ability Ss tended to provide more information.

The two grouping strategies led to nearly identical frequencies of information exchange among members of working groups. While the homogeneous grouping strategy resulted in a slightly larger amount of general discussion, the difference was restricted to one subgroup: homogeneous low-IQ Ss at School A. Apart from that subgroup, there was no evidence that grouping strategies differentially affect the amount of verbal interaction that occurs during group study of a program.

DISCUSSION

Two major difficulties that have been cited as impeding the assimilation of programmed instruction into the schools are: (1) that self-pacing leads to wide separation of activity among classmates because of their different rates of progress and (2) that many students for reasons of poor self-study skills, low initial motivation, or eventual boredom, may not respond well to prolonged isolation with a program source. Several recent studies have led to suggestions that both of these difficulties may be surmounted by administering programs to interacting groups rather than to individuals. It has even been suggested that such a procedure, in addition to its mitigation of teacher-management and student-motivation problems, may lead to achievement that is superior to that obtained from the individual study of programs.

The prospects for both instructors and learners offered by group administration appear to be indeed promising but dependent upon more comprehensive evaluation. Further evaluation is needed for theoretical purposes, to isolate the variables critical for social facilitation, and for practical purposes, to specify the administrative strategies by which programmed learning may be optimally facilitated for all students. If one is to employ group administration, it is necessary to know exactly how Ss should be permitted/required to interact and how the working groups should be constituted so as to enhance performance over the entire range of ability, prior knowledge, and learning rate that exists in the average class.

The purpose of this study was to evaluate, more comprehensively than has been accomplished in previous studies, the simple and interactive effects of several potentially critical variables during the administration of programmed instruction to interacting groups. Specifically, comparisons were made between high-and low-ability students working either in isolation or in one of three group settings that provided increasing degrees of social interaction, from simple sharing of a group pace, to group pacing plus public knowledge of results, to group pacing plus public knowledge of results plus freedom to discuss the material at length. Under each degree-of-interaction condition, work groups were constituted so as to be either homogeneous or heterogeneous in ability. The effects of each independent variable were assessed in terms of proficiency and transfer test scores obtained both immediately and after a delay of one week, error rates during the program, completion times, and student attitudes both toward the content and method of instruction.

The primary issue to which this study was directed was whether the introduction of various forms of social interaction into the programmed instructional setting facilitates or inhibits learning. A second major issue of concern was whether or not these effects are uniform for both low-and high-ability students placed in groups of uniform or mixed ability. The third major issue with which this study dealt was the extent to which students discuss programmed material when given the opportunity, and the nature of information exchange during that discussion.

The General Effects of Social Interaction on Programmed Learning

Under all four conditions, Ss displayed both substantial gains in proficiency and enhanced attitudes, particularly toward the subject matter of the program. Generally, then, it appears that these students acquired substantial knowledge of as well as a heightened regard for atomic physics.

However, apart from program completion time, performance measures provided little basis for choice among the four conditions of administration. Each led to comparable accuracy during the program as well as achievement and retention on criterion-tests. Moreover, each condition affected student attitude ratings very similarly. In terms of learning effectiveness, then, social interaction was neither facilitative or inhibitory.

Turning to learning efficiency, however, social interaction had a very clear effect. Compared to individual administration, every form of group administration resulted in the expenditure of more time to complete the lessons; learning in groups was less efficient than learning in isolation. Each increasing degree of social interaction was accompanied by a drop in learning efficiency. As students interacted more, they progressed more slowly. Thus, in terms of learning efficiency, social interaction was clearly inhibitory.

Individual and interacting-group administration of programs have been directly compared in four previous studies. Pairs of college students were observed by Dick (4) to require more time to complete the program than individuals, with no reliable differences in achievement. The results of Dick's study are thus similar to those of the present study. His pairs worked under conditions roughly comparable to Condition #3 of the present study, but apparently were not supervised and were thus able to discuss whatever they chose, whenever they chose.

Frye (7) obtained substantially similar results from ninth graders working either in isolation or in groups of homogeneous ability sharing only a group pace, much as was the case under

Condition #1 of the present study. However, he also found that when the pace-sharing groups were heterogeneous in ability, learning was less efficient. These findings of Frye are in partial agreement with those of the present study.

The results of the present study contrast sharply with those reported by Crist (3) and Parry (9), both of whom observed superior achievement as a function of social interaction. Parry, who studied classes of West African students, reported no difference in completion-time requirements between group and individual conditions. Crist, who compared four academically superior seventh graders, each of whom worked under both isolated and paired conditions, does not present completion time data. Parry's group situation was roughly comparable to Condition #1 of the present study, i.e., it involved group pacing. Crist's was like Condition #3, including public confirmation and discussion as well as group pacing. Both studies differed from the present study in two respects: (1) both observed younger students, and (2) both confounded presentation media with social interaction. Individual administration was accomplished with programmed booklets in all three studies. However, whereas the interacting groups in the present study worked from the same-style booklets used by the isolated Ss, Parry's groups worked from flip-charts and Crist's from projected transparencies. The possible novelty effects of the group media are thus not separable from the effects of social interaction in either of those two studies.

The Effects of Contrasting Strategies of Group Constitution

As might have been expected, uniformly high-ability groups required less time to complete the program than uniformly low-ability groups. The mixed-ability, or heterogeneous groups, required more than the former but less than the latter. The effect of mixing seems to have been to slow the more capable students while speeding the less capable.

Attitudes expressed toward methods of instruction did not differ among high-and low-ability Ss working either in uniform or mixed groups. But, attitudes toward atomic physics were affected by grouping strategy. The highest ratings were given by bright students who worked in mixed groups, while the low-ability Ss who worked in those same mixed groups gave the lowest ratings. It would appear that the mixing strategy tended to polarize high-and low-ability S's attitudes toward instructional content. It may be that these attitudes were affected by "access" to favorable comparisons. Since brighter students were more frequently correct relative to their group when the group contained less capable students, the bright students would experience greater numbers of favorable comparisons. On the other side of the coin, less capable students would experience fewer favorable comparisons when the group contained bright students.

Despite the tendencies for learning rate and attitude toward program content to be affected by grouping strategies, response accuracy during the program and later, on criterion tests, was unaffected. Comparing homogeneously and heterogeneously grouped Ss, they did not differ with respect to error rates or test scores.

Homogeneous and heterogeneous grouping strategies have been compared in three earlier studies. Frye's observation (7) that homogeneous groups required less time to complete the lesson is attributed to the possibility that more favorable conditions for competition existed within the homogeneous groups. Frye's findings were not verified by the present study. While the differences in completion-time requirements of the two kinds of groups were not statistically significant, homogeneous grouping tended to be less efficient than heterogeneous. This was particularly true under Condition #1, which was most similar to Frye's group setting. The lack of agreement between studies may be attributable to the fact that Frye's homogeneous groups consisted of medium ability Ss rather than uniformly low and uniformly high ability Ss as was the case in this experiment.

Dick and Seguin (5) compared the programmed learning of interacting pairs of students who were homogeneous or heterogeneous with respect to scores on the Berneuter Dominance Scale. While this represents a different dimension of similarity from that employed in the present study, it is relevant to the general problem of group formation strategies. Dick and Seguin observed no differences in performance between the two group types.

A 1964 study by Paulson (20) included a factorial comparison of two degrees of social interaction and heterogeneous as opposed to homogeneous grouping. Attending only to the performance of the lower-ability level of his ninth-grade Ss, he reports the superiority of public confirmation and discussion, similar to Condition #3 of the present study, to private confirmation. Public confirmation led to more discussion, including intragroup "tutoring," and higher achievement. It was hypothesized that the facilitation in achievement was due to the "intensified" reinforcement that accompanied knowledge of S's results relative to the group. As for grouping strategies, homogeneously grouped (low-ability) Ss achieved higher test scores. This was attributed to their greater "access" (degree of perceived success relative to the group) to reinforcement. No time differences or differences in attitude toward program content were found.

Paulson employed no control group but found that increasing the degree of interaction did facilitate achievement. The present study provides no confirmation for that finding. As for grouping strategies, the only evidence of benefit for homogeneous grouping of low-ability Ss was the previously discussed statistical interaction in attitudes toward atomic physics. Low-ability Ss who worked with other low-ability Ss rated the program higher than those who worked with brighter Ss. However, there was no evidence of a performance advantage from homogeneous grouping of low-ability Ss. In fact, this grouping arrangement lowered their learning efficiency, causing them to spend more time for no gain in program accuracy or achievement.

The Nature of Discussion During Programmed Instruction

Permitting discussion during a program represents a rather radical departure from the customary administration of programs to individuals in isolation. As pointed out in the introduction to this report, its possibilities both for facilitation and inhibition of learning are numerous. The Crist (3) and Paulson (20) results suggest that such discussion facilitates achievement. Paulson describes the "tutoring" value of discussion over and above its tendency to heighten student arousal. The collection of discussion data during Condition #3 of the present study made it possible to describe the patterns of interaction in somewhat more detail than was provided by previous studies.

Perhaps the first question that comes to mind is: how much discussion occurs during a program? The answer, from the present study, is: not very much. On the average, fewer than 12% of the frames of the Atomic Physics Program stimulated any kind of discussion. Of these, less than half of the discussions were rated by Es as involving content-relevant information exchange; the remainder consisted of other sorts of comments. Since the program was designed to be self-sufficient and to minimize errors and confusion, it is not surprising that students found relatively little to discuss. The overall average error rate was only about 8% indicating that, on most frames, there was no particular demand for additional information exchange. Discussion was inversely related to program accuracy, tending to be more frequent among groups that committed more errors during the program. While quantitative data relative to the frequency of discussion during linear programs is not available elsewhere, Paulson noted that accidental presentations of erroneous confirmation during his program were very provocative of discussion. Thus, it may reasonably be concluded that discussion among students during a program is inversely related to the accuracy of their responses to the program. To the extent that the program produces accurate responding, there is neither reason for, nor occurance of, intragroup discussion.

Even though a well-tried linear program stimulates discussion during only a small percentage of frames, it is of further interest to consider the qualitative features of the discussion that does occur. Less than half involved exchange of information about the subject matter. A modest (but not reliable) tendency was noted for less able Ss to seek more information while more able Ss provided more. Some of this discussion may be described as "tutoring" behavior like that observed by Paulson (20). One unanticipated feature of this discussion condition was that it was possible for students to disseminate their misconceptions about atomic physics. While the frequency of this phenomenon is not known, it did occur to some extent.

Social Facilitation and Programmed Instruction

Zajonc, in a recent review of the literature on social facilitation (27), points out that the dynamics and causes of social facilitation, although basic to social psychological theory, are no longer the subject of much research activity despite the fact that the basic questions remain unanswered. On the basis of what has been done in the area, he concludes that the presence of others facilitates performance of ongoing, learned behavior. However, when behavior is undergoing change, when learning is occuring, the simple presence of others exerts an inhibitory effect. He notes, in summary, that one practical suggestion from his review would be to advise a student . . . "to study all alone, preferably in an isolated cubicle, and to arrange to take his examinations in the company of many other students . . ."

If Zajonc is correct about learning in general, if isolation is superior to social interaction, then social inhibition should be particularly strong during learning from materials designed to be studied in isolation. In the sense that social interaction diminished learning efficiency, at least, the present study tends to support Zajonc's position although the achievement data conflict with it. The studies of Crist, Parry, and Paulson also seem to contradict that position. It may be, however, that the facilitation observed during those studies can be accounted for in terms of enhancement of performance of learned behaviors which are prerequisites to learning. For example, each of those investigators observed dramatic increases in the level of student arousal or motivation with added social interaction. Such changes may have compensated for failures to attend to the material under more isolated conditions. For example, although Ss were not being taught to read the frames, reading is a behavior which may not have been as well performed by Ss in isolation. Thus, social interaction may have facilitated achievement by dint of its facilitation of the performance of learned behaviors.

The general lack of agreement between the Crist and the Parry and Paulson studies on the one hand and the present study on the other may be due to the difference in students. The present sample was older, all Ss were volunteers, and except for Crist's sample, they had higher average IQ's. It may be that when either student or program characteristics lead to learning failures, the presence of others acts to remedy some of those failures. Given less intelligent, skilled, or motivated students and/or a less effective program, the results of the present study might have been different. An experiment that focuses on younger students and which includes an appropriate control group would seem justified before passing final judgment on group administration as a means of facilitating the incorporation of programmed instruction into the school setting.

CONCLUSIONS AND IMPLICATIONS

The results of several recent studies (3, 19, 20) suggest certain advantages for the administration of programs to interacting groups rather than to students working in isolation. It has been suggested that group study enhances both student motivation and learning. Since this social facilitation has been assessed in the context of several kinds of social interaction and with variously constituted work groups, the explicit conditions for social facilitation remain to be identified.

The results of the present study failed to confirm the suggestion that group interaction during the study of a program facilitates learning. Arranging for students to study a program in the context of small groups of interacting classmates is not always productive. In the case of high-school students studying a well-tried, linear program, its primary effect is to reduce learning efficiency. Such a program stimulates a relatively small amount of salient discussion among group members and social interaction contributes neither to achievement, retention, or student attitude toward instruction. Thus, given an effective program and a relatively capable group of high-school students, individual, self-paced administration seems clearly preferable to any of the group-administration strategies observed in the present study.

Despite the fact that social facilitation was not observed in this study, it would be imprudent to dismiss group administration as a possibly useful strategy. Considering the fact that students, particularly younger students, often do not respond well to isolation with a program either because the program or student self-study skills and/or motivation are less than optimal, it behooves us to consider group administration further. The evidence that has appeared recently for social facilitation among less sophisticated students is sufficiently promising to justify further investigation of this phenomenon.

SUMMARY

Problem

Recent research has indicated that social interaction during programmed learning may facilitate both student attitude and achievement. However, the particular factors which contribute to this facilitation have not been isolated. Since grouping students during programmed instruction can imply a wide range of possible situations, a more comprehensive analysis was felt necessary to identify the characteristics of group administration that differentiate learning in groups from learning in isolation.

Objectives

The objective of this study was to investigate the potentially facilitative and inhibitory effects of social interaction during programmed instruction under a wider range of conditions than previously has been studied. Specifically, the objectives were: (1) to identify the particular aspects of social interaction critical to facilitation or inhibition of programmed learning, and (2) to determine the method of constituting work groups that optimizes learning for students of both low and high ability.

Procedure

A 660-frame, linear program on atomic physics was administered to eleventh-grade students working either singly or in a group composed of four classmates. The groups were constituted so as to be either homogeneous or heterogeneous in ability. Groups of each type worked under one of three conditions of administration that provided for increasing degrees of social interaction. Three different types of interaction were provided by: (A) group-determined pacing; (B) public knowledge of group results during the program; and (C) group discussion during the program. An "add-on" design was employed in which Condition #1 included only group pacing; Condition #2 included both group pacing and public knowledge of results; and Condition #3 included both group pacing and public knowledge of results as well as group discussion. Control-group students worked individually, each at his own pace. All students were provided with a programmed booklet. The experiment was repeated at three different schools. Dependent measures included: accuracy during the program; completion time; immediate and delayed criterion-test scores; and student attitudes toward the content and method of instruction.

Results

Social interaction had no differential effect on any dependent measure except completion time. Time required to complete the program was a direct function of the degree of social interaction permitted. Thus, learning efficiency was inhibited by social interaction.

Comparing homogeneous and heterogeneous groups, they did not differ on any performance or attitude measure. Comparing the various subgroups, learning efficiency tended to be lowest for homogeneous low-ability groups and highest for homogeneous high-ability groups. The effect of mixing ability levels into heterogeneous groups was to raise efficiency for the low-ability students while, at the same time, lowering efficiency for the brighter students. Thus, no grouping strategy was found to optimize learning for students of both high and low ability.

The frequency of intra-group discussion tended to be inversely related to accuracy during the program. On the average, discussion occurred during about 12% of the program frames. Although information tended to be sought more frequently by lower-ability students and provided more frequently by higher-ability students, these differences were not reliable.

Conclusions

The results of this study indicate that social interaction during programmed instruction can *inhibit rather than facilitate* learning. When the program leads to relatively low error rates and high achievement under conditions of individual administration, the introduction of social interaction impedes learning efficiency without affecting achievement or attitude.

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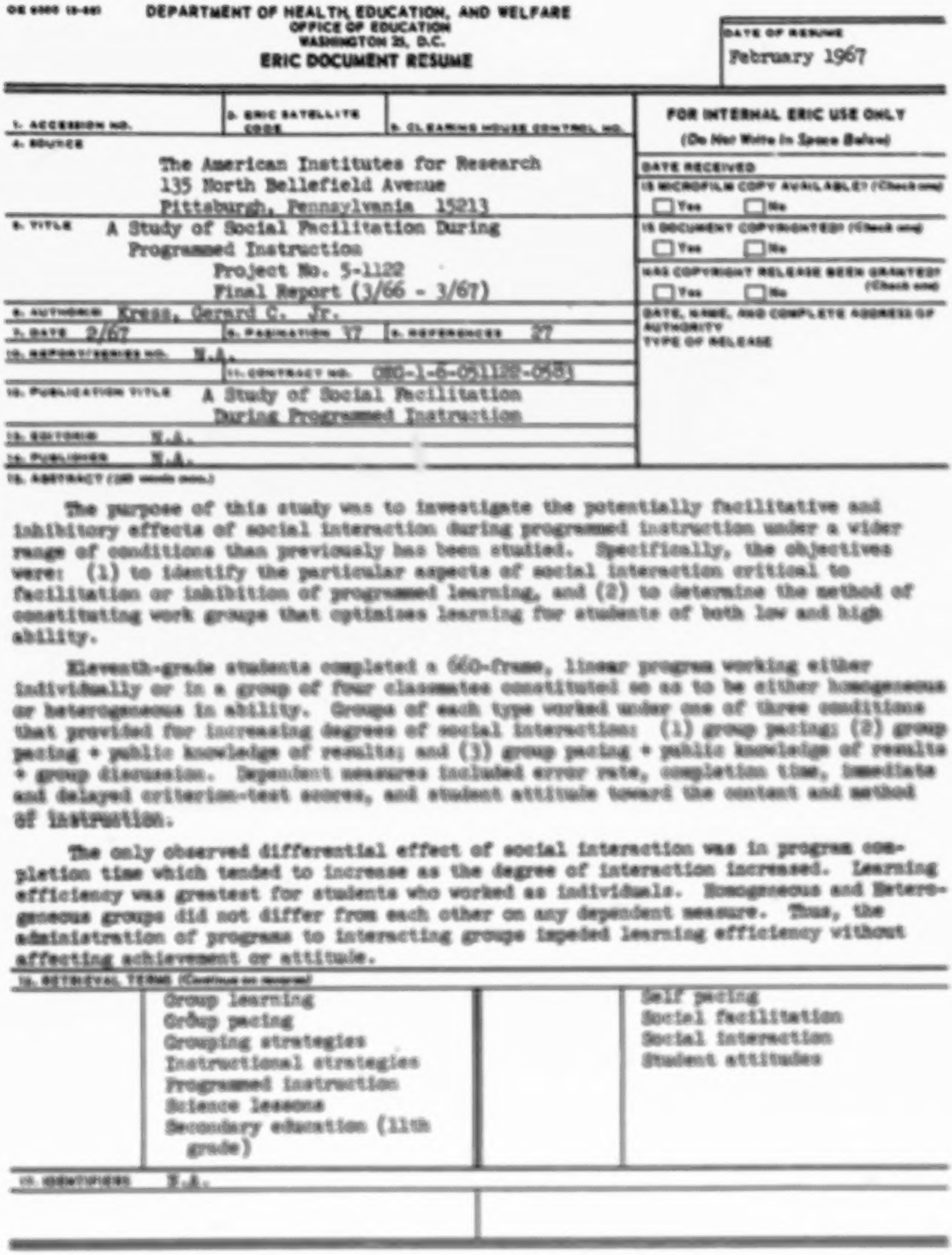

OE 6000 (5-66)

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
OFFICE OF EDUCATION
WASHINGTON 25, D.C.
ERIC DOCUMENT RESUME

DATE OF RESUME February 1967

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15. ABSTRACT (250 words max.)

The purpose of this study was to investigate the potentially facilitative and inhibitory effects of social interaction during programmed instruction under a wider range of conditions than previously has been studied. Specifically, the objectives were: (1) to identify the particular aspects of social interaction critical to facilitation or inhibition of programmed learning, and (2) to determine the method of constituting work groups that optimizes learning for students of both low and high ability.

Eleventh-grade students completed a 660-frame, linear program working either individually or in a group of four classmates constituted so as to be either homogeneous or heterogeneous in ability. Groups of each type worked under one of three conditions that provided for increasing degrees of social interaction: (1) group pacing; (2) group pacing + public knowledge of results; and (3) group pacing + public knowledge of results + group discussion. Dependent measures included error rate, completion time, immediate and delayed criterion-test scores, and student attitude toward the content and method of instruction.

The only observed differential effect of social interaction was in program completion time which tended to increase as the degree of interaction increased. Learning efficiency was greatest for students who worked as individuals. Homogeneous and Heterogeneous groups did not differ from each other on any dependent measure. Thus, the administration of programs to interacting groups impeded learning efficiency without affecting achievement or attitude.

16. RETRIEVAL TERMS (Continue on reverse)

Group learning
Group pacing
Grouping strategies
Instructional strategies
Programmed instruction
Science lessons
Secondary education (11th grade)

Self pacing
Social facilitation
Social interaction
Student attitudes

17. IDENTIFIERS N.A.

Figure 3. ERIC Document Resume

APPENDIX A

Sample Materials

Page

1. Atomic Physics Program excerpts A-1

2. Pretest Instructions. A-12

3. Proficiency Test. A-13

4. Transfer Test A-18

5. Rating Scales used to measure
student attitudes A-23

ATOMIC PHYSICS PROGRAM*

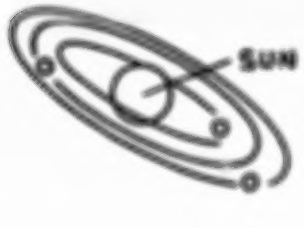
Unit A: The Atom
(sample page)

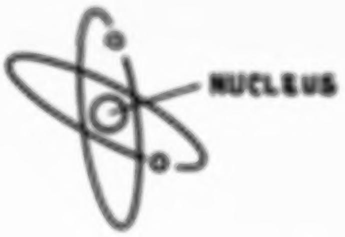
A-56 An ion is an ATOM that is not neutral; it has either too few or too many ELECTRONS compared to its number of protons.

A-44 Protons are positively CHARGED particles. Electrons are NEGATIVELY CHARGED PARTICLES.

A-32 All substances consist of atoms. A substance consisting of only one kind of atom is called an ELEMENT. Every atom consists of a NUCLEUS at its center with ELECTRONS in orbit around it.

A-20 In our solar system, the planets move in paths, called orbits, around the sun. In an atom there are small particles called electrons which move in ORBITS (PATHS) around the NUCLEUS.





A-8 A substance which consists of only one kind of atom is called an element. Any substance consisting of more than one kind of atom is not an ELEMENT.

---

*Subjects were required to make constructed responses for all frames. The sample frames reproduced here are those which were presented to them as confirmation frames after they had made their own responses. The correct constructed responses appear in capital letters.

ATOMIC PHYSICS PROGRAM

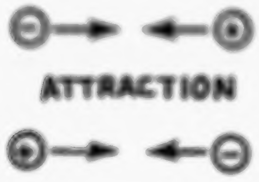
Unit B: Atomic Particles
(sample page)

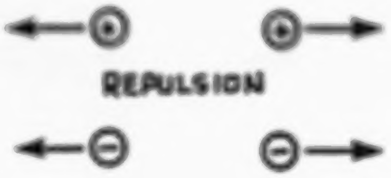
rA-1 All substances are made up of ATOMS. A substance consisting of only one KIND of atom is called an element.

B-3 A neutral atom has an equal number of positive and negative charges. This means that there are as many ELECTRONS in orbit as there are PROTONS (POSITIVE CHARGES) in the nucleus.

B-17 Protons and electrons have opposite charges, but the size of charge on an electron is exactly EQUAL (THE SAME) to the size of charge on a proton.

B-31 The general rule of attraction or repulsion is that like charges REPEL each other, and UNLIKE CHARGES ATTRACT EACH OTHER.





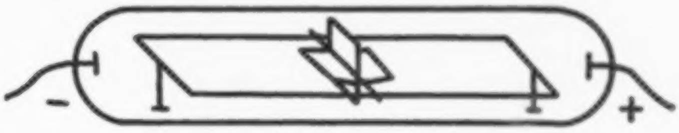
B-45 The NUCLEUS at the center of most atoms contains both PROTONS AND NEUTRONS.

ATOMIC PHYSICS PROGRAM

Unit C: Cathode Rays
(sample page)

rB-7 The charge on atomic particles is very small. Electrons have the smallest NEGATIVE charge possible and protons have the SMALLEST POSITIVE CHARGE POSSIBLE.

C-14 A tube was built with a pinwheel resting on tracks. If light rays were focused on the pinwheel, they would exert no force, and the pinwheel would NOT move.



C-30 The Earth consists of more matter than a baseball, therefore the mass of the Earth is GREATER than that of a baseball. The greater the mass of an object, the greater is the AMOUNT OF MATTER in it.

C-46 An object would weigh less on the moon because the moon has less MASS than the Earth and hence the FORCE OF ATTRACTION between the object and the moon would be smaller.

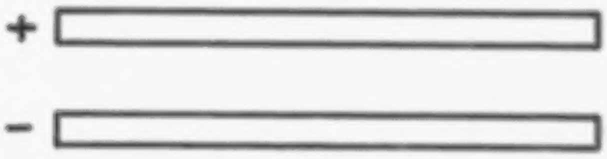
C-62 Because electrons could cause a pinwheel placed inside a CATHODE RAY tube to move, they knew electrons had both MASS and VELOCITY.

ATOMIC PHYSICS PROGRAM

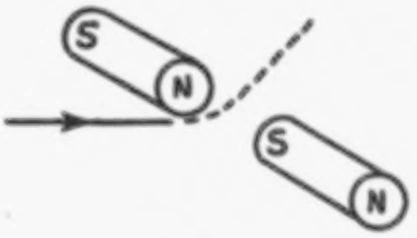
Unit D: Measuring the Electron
(sample page)

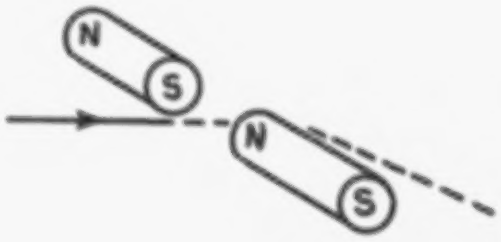
rC-4 Electrons making up cathode rays were found to have both mass and velocity. Velocity means SPEED, and MASS means the amount of MATTER in an object.

D-11 Positively charged particles passing through an ELECTRIC field will be ATTRACTED by the negative plate. Negatively charged particles will be ATTRACTED by the positive plate.



D-25 As shown in the figure, if the electrons come from the left and North is toward you, the beam will be deflected UPWARD. If North is away from you, the beam will be deflected DOWNWARD.





D-39 Thomson found that the velocity of the electrons depended on the voltage between the cathode, or negative terminal, and the anode, or POSITIVE TERMINAL.

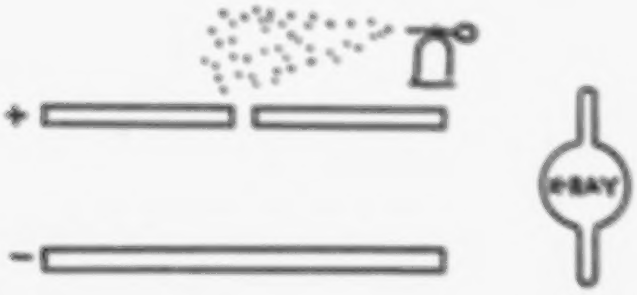
D-53 Since e/m always turned out to be the same number, physicists concluded that all electrons were probably alike; each electron having exactly the same CHARGE (MASS) and the same MASS (CHARGE) as every other electron.

ATOMIC PHYSICS PROGRAM

Unit E: Charge & Mass of the Electron
(sample page)

rD-3 A beam of electrons will be deflected by magnetic fields and by ELECTRIC FIELDS. This would not be true if electrons did not have an electrical CHARGE.

E-6 If the X-ray tube and charged plates were turned off, the drop of oil would fall down toward the lower plate due to the force of GRAVITY.



E-18 Millikan took hundreds of measurements on drops with different charges. He found that the amount of charge on the drops varied, as indicated by the difference between their downward and UPWARD VELOCITIES.

E-30 Electrons are very small PARTICLES of matter which have a NEGATIVE charge.

E-42 Because it contains all of the protons, the nucleus of every atom has a POSITIVE charge. If an atom loses all of its electrons, only the NUCLEUS will be left.

ATOMIC PHYSICS PROGRAM

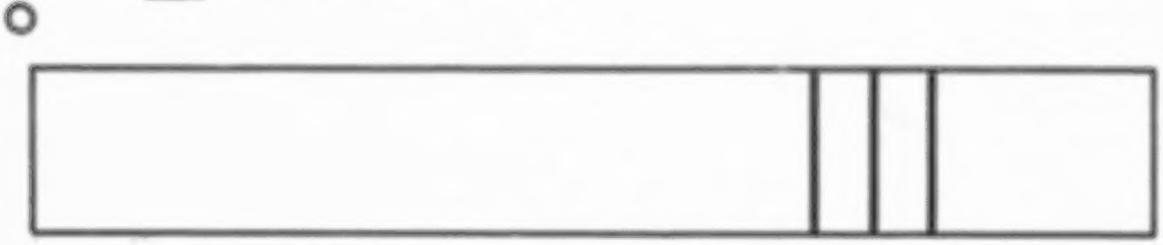
Unit F: The Mass of Atoms
(sample page)

rE-4 In Millikan's experiment, oil drops picked up ELECTRONS knocked loose from atoms in the air. This gave the drops a NEGATIVE charge.

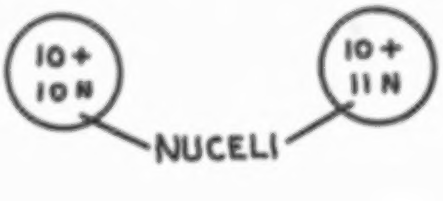
F-11 The degree of deflection of a positive ion in a combined magnetic and electric field depends both on its charge and mass. The greater the charge, the GREATER the deflection.

F-27 By observing how much ions with the SAME amount of charge are DEFLECTED in a mass spectrograph, it is possible to determine the relative MASSES of positive ions of different elements.

F-43 After measuring the mass of hydrogen and helium atoms, Thomson put neon gas in the tube. Instead on one line, however, he got three. This meant that all neon atoms do NOT have the same mass.



F-59 One nucleus has 10 protons and 10 neutrons; another has 10 protons and 11 neutrons. Both are nuclei of the same ELEMENT, neon, but they are different ISOTOPES of that element.



ATOMIC PHYSICS PROGRAM

Unit G: Isotopes and Mass Numbers
(sample page)

G-35 The number of nucleons in a nucleus is the sum of the number of PROTONS (NEUTRONS) and NEUTRONS (PROTONS). The number of nucleons is indicated by the MASS (A) number.

G-23 $_6C^{12}$ is an isotope of carbon. The "C" stands for CARBON, "6" is the ATOMIC number, and "12" is the MASS NUMBER.

6+
6N
NUCLEUS
$_6C^{12}$

G-11 All isotopes of the same element have the same number of protons. This is the same as saying they all have the same ATOMIC NUMBER.

rF-12 Neon atoms having different masses are called isotopes of neon. Atoms of all ISOTOPES of any one element have the same number of PROTONS but may have different numbers of NEUTRONS.

ATOMIC PHYSICS PROGRAM

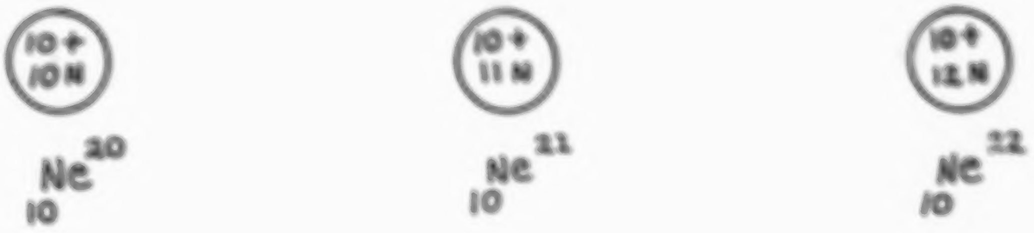
Unit H: Measuring Atomic Mass
(sample page)

rG-3 The total number of nucleons in a nucleus is indicated by the MASS number. An $_8O^{17}$ nucleus contains 17 nucleons, of which 8 are PROTONS, and 9 ARE NEUTRONS.

H-6 The mass of the hydrogen atom is no longer used as the standard. A more convenient STANDARD amount of mass, the mass of the oxygen isotope $_8O^{16}$ is now used.

H-18 The mass of nitrogen, $_7N^{14}$, is 14.0075 amu. This is very close to its mass number of 14.

H-30 The nuclei of the 3 neon isotopes are represented in the figure. The most abundant neon isotope is $_{10}Ne^{20}$. An atom of $_{10}Ne^{20}$ has a mass of approximately 20 atomic mass units.



H-42 One isotope of sulfur is $_{16}S^{34}$. A $_{16}S^{34}$ nucleus contains 34 nucleons, of which 16 are protons and 18 are neutrons.

ATOMIC PHYSICS PROGRAM

Unit I: Discovery of the Nucleus
(sample page)

rE-7 Atomic masses based on $_8O^{16}$ as a standard are convenient because then an atom's actual mass in ATOMIC MASS UNITS is almost the same as its MASS number.

I-10 As a positive particle passes through evenly distributed charges, the forces deflecting it in one direction are NOT any stronger than the forces DEFLECTING it in any other direction.

I-24 Geiger and Marsden bombarded atoms with ALPHA particles. They studied the scattering of the particles to see how much the particles had been DEFLECTED (SCATTERED) as they passed through the atom.

I-38 In an atom, positive charges are all in the NUCLEUS, and electrons orbit at some distance from it; therefore, most of the space occupied by an atom consists of NO matter at all.

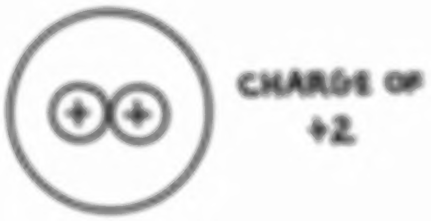
I-52 The first scattering experiments indicated that the positive charges within an atom are NOT EVENLY DISTRIBUTED (CONCENTRATED IN THE CENTER (NUCLEUS)).

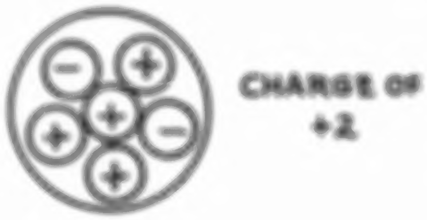
ATOMIC PHYSICS PROGRAM

Unit J: Structure of the Nucleus
(sample page)

J-27 The nucleus of an atom of lithium (lith-ee-um) has a mass of 7 and a charge of +3. This would be possible if it contained 7 protons and 4 electrons.

J-17 A helium nucleus would have a charge of +2 if it contained 2 protons. It would also have a charge of +2 if it contained 4 protons and 2 electrons.





J-7 An atom which has 2 + charges and 2 - charges is a NEUTRAL ATOM. An atom which has 4 + charges and 5 - charges is NOT A NEUTRAL ATOM (NOT NEUTRAL, NEGATIVELY CHARGED), it is a negative ION.

rI-7 The wide deflections of alpha particles passing through atoms indicated that the POSITIVE charges in an atom are not EVENLY distributed.

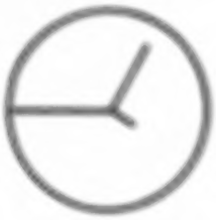
ATOMIC PHYSICS PROGRAM

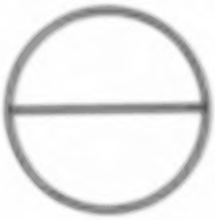
Unit K: Discovery of the Neutron
(sample page)

rJ-4 If the number of orbiting electrons exactly equals the number of protons, the atom is NEUTRAL. Both the number of protons and electrons is then indicated by the ATOMIC number.

K-10 The protons could have been knocked out of nitrogen nuclei. They also could have been knocked out of one of the ALPHA PARTICLES which struck a nitrogen nucleus.

K-22 The figure at the left shows that a collision has occurred. The figure at the right does not show THAT A COLLISION HAS OCCURRED.





K-34 As a charged particle passes near other CHARGED PARTICLES, it will be either attracted or repelled by them and be SLOWED down in speed.

K-46 The correct structure of the nucleus was finally determined when the neutron was discovered. Nuclei contain only two kinds of particles, PROTONS (NEUTRONS) and NEUTRONS (PROTONS).

INSTRUCTION PAGE ATTACHED TO
PROFICIENCY TEST DURING PRETEST ADMINISTRATION

Knowledge of Atomic Physics

Instructions

Name: ______________________________ Date: ______________________

School: ____________________________ Condition: __________________

On the following pages are some questions to assess your knowledge of atomic physics. Each question contains one or more blanks which you are to fill in. Whenever you come to a blank, give the answer you think belongs there. When you see a blank: __________, it means that one word belongs there. When you see a blank with a star: * __________, it means that two or more words belong there and all the words must be given. A blank with two stars: ** ______________, means you are to answer in your own words. A blank like this: # ______, means that a number should be used; a blank like this: $ _____, means a symbol, such as a letter or a plus (+) sign belongs there. Words should not be used. Now try the following examples:

1. When we measure the length of something we see how many units long it is. A pencil, for example, is about six __________ long and a log might be about ten * ______________________.
2. 36 inches equals # ____ feet, because 36 $ _____ 12 = 3.

The answers you should have filled in for number 1 are "inches" and "feet long." In number 2 you should have written "3" and "÷."

PROFICIENCY TEST

__________________ test

Name: ______________________________ Date: __________

School: ______________________________ Condition: ________

Knowledge of Atomic Physics

Part I

Answer each of the following questions by filling in the missing words, numbers, or symbols.

1. An electron has a ______________ electrical charge, a proton has a ______________________________, and a neutron ** ______________________________.

2. The number of protons in the ______________ of an atom is indicated by the * __________________________ of the element. The nuclei of all atoms of the same element have exactly the same number of ____________.

3. The first things discovered about cathode rays were that they move in a ______________________________ and that they are particles having both ______________ and ______________.

4. An electric field deflects a beam of electrons, and so will a * ______________________. Both fields exert a __________ on charged particles passing through them.

5. When a $_2He^4$ strikes a nitrogen nucleus, a * ______________________ occurs. The two particles produced are ** ______________________________.

6. A neutral $_2He^4$ atom has # _____ orbiting electrons, and a neutral $_8O^{17}$ atom has # _____ orbiting electrons. (Use numbers.)

7. $_8O^{16}$ is the standard used for measuring atomic mass in amu's. Amu stands for * ______________________________. One amu is defined as ** ____.

8. There are two kinds of nucleons; ____________ and ____________, each with approximately the same amount of __________. There are ______ electrons in an atomic nucleus.

9. A neutral atom is one which has ** ____________________________ ______________________________.

10. The amount an ion is deflected depends both on its * ______________ ____________. Deflection will be greatest when the ion's __________ is small and when the amount of charge is ____________.

11. Isotopes of the same element have ** ____________________________ ____.

12. In Millikan's experiment, oil drops picked up ____________ knocked loose from atoms in the air. This gave the drops a ______________ charge.

13. Einstein's mass-energy equation indicates the precise relationship between * ______________________________. A very small amount of mass is equivalent to ** ____.

14. The equation ${}_2He^4 + {}_{13}Al^{27} \longrightarrow$ means that an * ________________________ combines with an aluminum ____________ in a * ________________________.

15. The downward velocity of the oil drops in Millikan's experiment depended only on their __________, while their upward velocity depended both on their * __________________________________.

16. The total number of nucleons in a nucleus is indicated by the __________ number. An ${}_8O^{17}$ nucleus contains # _____ nucleons, of which 8 are __________ and * ______________________________. (Use numbers.)

17. A cathode ray consists of a beam of negatively charged ______________ which were found to stream from the negative terminal, or ____________, of a specially designed vacuum tube.

18. Wide deflections of alpha particles in ________________ experiments indicated that, in the atom, all of the ** ____________________________ ____________________________.

58

19. The ratio, e/m, of an electron is always * ______________________. This led physicists to conclude that all electrons have the ** ________________ ______________________________________.

20. Helium's atomic number is 2, which means its nucleus has # ____ positively charged _______________, and that a neutral helium atom has * __________ __________________ in orbit.

21. ${}_2He^4 + {}_4Be^9 \longrightarrow {}_0n^1$ + (a nucleus). The Z number of the new nucleus is # ______ and its A number must be # ______.

22. Scattering experiments have furnished information on the structure of the atom, since large deflections in the paths of alpha particles indicated that ** ____ ___________________________________.

23. Atoms of different elements are different because they have ** ______________ ____________________________________ in their nuclei. Isotopes of the same element differ because ** ____ ____.

24. By knowing the number of ________________ in a nucleus of a neutral atom, it is possible to deduce the number of _______________ in orbit; for each proton, there has to be one __________________.

25. In any nuclear reaction, energy is released whenever __________ disappears. The ____________ that disappears has been *____________________________ _______________.

26. $_{82}Pb^{206}$ is one of the ____________ of the element lead. It has #______ protons, #______ neutrons, and a neutral $_{82}Pb^{206}$ atom has #_____ electrons.

TRANSFER TEST

__________ test

Name: ____________________ Date: __________

School: ____________________ Condition: __________

Knowledge of Atomic Physics

Part II

Answer each of the following questions by filling in the missing words, numbers, or symbols.

1. The three basic particles in atoms are * ____________________ __________. In terms of their charge, they differ in that ** ____________________ ____________________.

2. An ion is an atom which is not __________ because it ** __________ ____________________.

3. The difference between an element, such as carbon, and a compound, such as chalk, which is not an element, is that an element ** __________ ____________________, whereas a compound ** __________ ____________________.

4. An electron stays in orbit because ** ____________________ ____________________ ____________________.

5. Cathode rays and light rays are different in that ** __________ ____________________. Physicists knew that cathode rays were not like light rays because ** __________ ____________________.

6. The difference between mass number and amu is that the mass number indicates ** ____________________ and amu means ** ____________________.

7. The equation for the reaction in which a neutron combines with an $_8O^{16}$ nucleus to form a different isotope of oxygen, when no free particle is emitted, is

\$ ______________________________

(Use symbol)

8. When nitrogen, $_7N^{14}$, is bombarded with an alpha particle, it becomes oxygen, O, plus another particle. The equation is

$_7N^{14}$ + \$ ______ ⟶ \$ ______ + \$ ______

(Use symbol)

9. The complete symbol for the atom in the table below is \$ __________.

Z	A	Element	Mass in amu
3		Lithium (Li)	6.01692

10. Sometimes mass disappears during a nuclear reaction. When this happens, ** ______________________________. If mass is produced in a reaction, ** ______________________________.

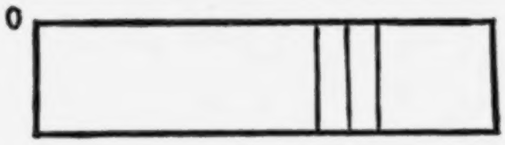
11. Mass and weight do not have the same meaning. Mass is the ** ______________________________ while weight is a measure of the * ______________________________ between objects.

12. Cathode rays passing between oppositely charged plates will be ** ______________________________ because ** ______________________________.

13. Millikan measured the ____________ on an electron in his * _________________ experiment. He was then able to calculate the ______________ of an electron using Thomson's e/m ratio.

14. As an alpha particle passes through an electric field, it will be ** ________ ____ because it has * ____________ ___________________________.

15. This is a mass spectrograph record of a single element as it occurs in nature. It indicates that ** ____.



16. The fact that an element may have several isotopes, means that ** ____________ ____.

17. "Scattering" refers to a type of experiment in which ** ___________________ ____.

18. In order for any particle to have a charge of +4 it must ** _______________ ____.

19. In his cathode ray tube, Thomson could deflect the beam of electrons either upwards or downwards by ** ____

____.

20. Complete the following nuclear reaction.

$${}_{5}B^{11} + {}_{2}He^{4} \longrightarrow \$\_\_\_\_\_\_\_\_ + {}_{1}H^{1}$$

Element	Symbol
Boron	${}_{5}B$
Carbon	${}_{6}C$
Nitrogen	${}_{7}N$
Oxygen	${}_{8}O$

21. An alpha particle can easily pass through an atom because ** ____________________

____.

22. Most of the mass of an atom is in * __________________________ because the mass of a ___________________ or a ___________________ is about # ________ times as large as the mass of an _____________________.

23. Neutrons are more penetrating than protons because ** ________________________

____.

24. A cloud chamber is useful in studying nuclear particles because ** ______________

____.

25. If you wanted to separate isotopes of an element and had to choose between using a chemical method or a mass spectrograph you should choose the *________________________________ because **________________________ ____.

26. Millikan, in his oil drop experiment, studied the amount of *________________ ________________________ by observing the difference in the *________ ____ of the oil drops.

RATING SCALES USED TO MEASURE STUDENT ATTITUDES*

RATING SCALES

Instructions:

The purpose of this form is to measure what certain things mean to various people by having them judge the things against a series of descriptive scales. In rating the things to follow, please make your judgements on the basis of what they mean to you. A number of different things are listed on the following pages, with a set of scales beneath each one. You are to rate each thing on each scale in order.

Here is how to use the scales:

If you feel that the thing you are rating is very closely related to one end of the scale, you should place your checkmark as follows:

Good __X__:_____:_____:_____:_____:_____:_____ Bad
or
Good _____:_____:_____:_____:_____:_____:__X__ Bad

If you feel that the thing is quite closely related to one or the other end of the scale (but not extremely), you should place your checkmark as follows:

Good _____:__X__:_____:_____:_____:_____:_____ Bad
or
Good _____:_____:_____:_____:_____:__X__:_____ Bad

If the thing seems only slightly related to one side as opposed to the other side (but is not really neutral), then you should check as follows:

Good _____:_____:__X__:_____:_____:_____:_____ Bad
or
Good _____:_____:_____:_____:__X__:_____:_____ Bad

The direction toward which you check, of course, depends upon which of the two ends of the scale seem most characteristic of the thing you're judging.

If you consider the thing to be neutral on the scale, both sides of the scale equally associated with it or if the scale is completely irrelevant unrelated to the thing, then you should place your checkmark in the middle space:

---

*Aggregate scores on the first, fourth, and sixth scales were taken as a measure of attitude toward program content. Aggregate scores on the second, third, and fifth scales were taken as a measure of attitude toward methods of instruction.

Good ____:____:____:__X__:____:____:____ Bad

Important: (1) Place your checkmarks in the middle of spaces, not on the boundaries:

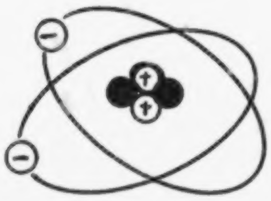
This X- Not this
Good ____:__X__:____:____:____:____:____ Bad

(2) Be sure you check every scale.

(3) Never put more than one checkmark on a single scale.

Sometimes you may feel as though you've had the same item before. This will not be the case, so don't bother looking back and forth through the items. Don't try to remember how you marked similar items on earlier scales; make each item a separate and independent judgement. It is your first impressions, the immediate "feelings" about the items, that we want. On the other hand, please do not be careless because we want your true impressions.

Turn to the next page and begin.



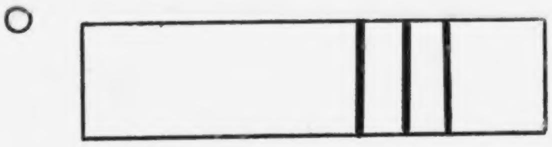
1. Good ____:____:____:____:____:____:____ Bad
2. Cruel ____:____:____:____:____:____:____ Kind
3. Painful ____:____:____:____:____:____:____ Pleasurable
4. Successful ____:____:____:____:____:____:____ Unsuccessful
5. High ____:____:____:____:____:____:____ Low
6. Meaningless ____:____:____:____:____:____:____ Meaningful
7. Important ____:____:____:____:____:____:____ Unimportant
8. Ugly ____:____:____:____:____:____:____ Beautiful
9. Hopeless ____:____:____:____:____:____:____ Hopeful
10. Graceful ____:____:____:____:____:____:____ Awkward

LEARNING FROM A PROGRAMMED LESSON

1. Good ____:____:____:____:____:____:____ Bad
2. Cruel ____:____:____:____:____:____:____ Kind
3. Painful ____:____:____:____:____:____:____ Pleasurable
4. Successful ____:____:____:____:____:____:____ Unsuccessful
5. High ____:____:____:____:____:____:____ Low
6. Meaningless ____:____:____:____:____:____:____ Meaningful
7. Important ____:____:____:____:____:____:____ Unimportant
8. Ugly ____:____:____:____:____:____:____ Beautiful
9. Hopeless ____:____:____:____:____:____:____ Hopeful
10. Graceful ____:____:____:____:____:____:____ Awkward

LEARNING WITH TEAMMATES

1. Pleasant ____:____:____:____:____:____:____ Unpleasant
2. Friendly ____:____:____:____:____:____:____ Unfriendly
3. Bad ____:____:____:____:____:____:____ Good
4. Worthless ____:____:____:____:____:____:____ Valuable
5. Distant ____:____:____:____:____:____:____ Close
6. Cold ____:____:____:____:____:____:____ Warm
7. Quarrelsome ____:____:____:____:____:____:____ Harmonious
8. Self-Assured ____:____:____:____:____:____:____ Hesitant
9. Efficient ____:____:____:____:____:____:____ Inefficient
10. Gloomy ____:____:____:____:____:____:____ Cheerful



1. Good ____:____:____:____:____:____:____ Bad
2. Cruel ____:____:____:____:____:____:____ Kind
3. Painful ____:____:____:____:____:____:____ Pleasurable
4. Successful ____:____:____:____:____:____:____ Unsuccessful
5. High ____:____:____:____:____:____:____ Low
6. Meaningless ____:____:____:____:____:____:____ Meaningful
7. Important ____:____:____:____:____:____:____ Unimportant
8. Ugly ____:____:____:____:____:____:____ Beautiful
9. Hopeless ____:____:____:____:____:____:____ Hopeful
10. Graceful ____:____:____:____:____:____:____ Awkward

YOUR TEAMMATE(S)

1. Pleasant ____:____:____:____:____:____:____ Unpleasant
2. Friendly ____:____:____:____:____:____:____ Unfriendly
3. Bad ____:____:____:____:____:____:____ Good
4. Worthless ____:____:____:____:____:____:____ Valuable
5. Distant ____:____:____:____:____:____:____ Close
6. Cold ____:____:____:____:____:____:____ Warm
7. Quarrelsome ____:____:____:____:____:____:____ Harmonious
8. Self-Assured ____:____:____:____:____:____:____ Hesitant
9. Efficient ____:____:____:____:____:____:____ Inefficient
10. Gloomy ____:____:____:____:____:____:____ Cheerful

ATOMIC PHYSICS

1. Good ____:____:____:____:____:____:____ Bad
2. Cruel ____:____:____:____:____:____:____ Kind
3. Painful ____:____:____:____:____:____:____ Pleasurable
4. Successful ____:____:____:____:____:____:____ Unsuccessful
5. High ____:____:____:____:____:____:____ Low
6. Meaningless ____:____:____:____:____:____:____ Meaningful
7. Important ____:____:____:____:____:____:____ Unimportant
8. Ugly ____:____:____:____:____:____:____ Beautiful
9. Hopeless ____:____:____:____:____:____:____ Hopeful
10. Graceful ____:____:____:____:____:____:____ Awkward

APPENDIX B

Analysis of Variance and Mean and S.D. Summaries

Page

1. Analyses based on the 3 x 4 x 2 design including the Control Group . . . B-1
2. Analyses based on the 3 x 3 x 2 x 2 design excluding the Control Group . . . B-8
3. Analyses of discussion responses B-14

Table 1-B

Summaries of Analyses of Variance of IQ, Atomic Physics PRETEST Scores and PRE-EXPERIMENTAL ATTITUDES Toward CONTENT and METHODS of Instruction

(3 x 4 x 2 Design)

	Source	D.F.	Mean Squares	F
IQ	School	2	673.80	13.87**
	Degree of Interaction	3	8.83	-
	IQ	1	12886.58	265.24**
	S x D	6	6.46	-
	S x I	2	11.47	-
	D x I	3	17.22	-
	S x D x I	6	11.55	-
	Within Replicates	142	48.58	
PRETEST ATOMIC PHYSICS	School	2	4993.48	19.96**
	Degree of Interaction	3	264.90	1.06
	IQ	1	10539.61	42.14**
	S x D	6	107.27	-
	S x I	2	415.48	1.66
	D x I	3	167.79	-
	S x D x I	6	207.34	-
	Within Replicates	140	250.14	
PRE-EXPERIMENTAL CONTENT ATTITUDE SCORES	School	2	824.39	2.79
	Degree of Interaction	3	100.14	-
	IQ	1	3.72	-
	S x D	6	840.36	2.84*
	S x I	2	559.07	1.89
	D x I	3	78.07	-
	S x D x I	6	294.10	-
	Within Replicates	142	295.49	
PRE-EXPERIMENTAL METHODS ATTITUDE SCORES	School	2	2518.30	6.18**
	Degree of Interaction	3	146.29	-
	IQ	1	183.33	-
	S x D	6	398.15	-
	S x I	2	382.40	-
	D x I	3	200.96	-
	S x D x I	6	341.59	-
	Within Replicates	142	568.96	

* significant beyond the .05 level

** significant beyond the .01 level

Table 2-B

Summary Means and S.D.'s of IQ Scores
(N = 166)

Levels of Independent Variables		Mean	S.D.	Sign. Level
SCHOOL	School A	122.66	10.36	<.01
	School B	116.56	11.36	
	School C	118.71	11.79	
DEGREE OF INTERACTION	Condition #1	119.34	12.24	N.S.
	Condition #2	118.82	11.08	
	Condition #3	120.07	10.63	
	Control	119.34	12.09	
IQ	High	128.08	5.67	<.01
	Low	110.51	8.53	

Table 3-B

Summary Means and S.D.'s of Percentage Scores on Atomic Physics PRETEST
(N = 166)

Levels of Independent Variables		Mean	S.D.	Sign. Level
SCHOOL	School A	31.86	22.17	<.01
	School B	21.80	18.03	
	School C	12.87	10.42	
DEGREE OF INTERACTION	Condition #1	25.58	21.24	N.S.
	Condition #2	22.62	18.23	
	Condition #3	20.66	18.96	
	Control	20.46	18.51	
IQ	High	30.35	19.87	<.01
	Low	14.39	14.85	

Table 4-B

Summary Means and S.D.'s of PRE-EXPERIMENTAL Scores on CONTENT ATTITUDE Scales
(N = 166)

Levels of Independent Variables		Mean	S.D.	Sign. Level
SCHOOL	School A	11.37	17.22	N.S.
	School B	17.98	19.88	
	School C	18.81	15.48	
DEGREE OF INTERACTION	Condition #1	15.39	15.36	N.S.
	Condition #2	14.82	16.16	
	Condition #3	18.24	22.47	
	Control	14.69	16.28	
IQ	High	16.13	15.75	N.S.
	Low	15.65	19.89	

Table 5-B

Summary Means and S.D.'s of PRE-EXPERIMENTAL Scores on METHODS ATTITUDE Scales (N = 166)

Levels of Independent Variables		Mean	S.D.	Sign. Level
SCHOOL	School A	33.61	26.11	< .01
	School B	39.31	22.13	
	School C	49.38	20.36	
DEGREE OF INTERACTION	Condition #1	39.48	25.93	N.S.
	Condition #2	42.75	23.44	
	Condition #3	38.63	24.52	
	Control	41.19	21.30	
IQ	High	41.31	20.24	N.S.
	Low	39.55	27.21	

Table 6-B

Summaries of Analyses of Variance of IMMEDIATE PROFICIENCY and TRANSFER Scores (3 x 4 x 2 Design)

	Source	D.F.	Mean Squares	F
IMMEDIATE PROFICIENCY SCORE	School	2	1357.03	6.62**
	Degree of Interaction	3	67.11	-
	IQ	1	13249.42	64.63**
	S x D	6	59.96	-
	S x I	2	513.57	2.51
	D x I	3	133.34	-
	S x D x I	6	82.03	-
	Within Replicates	142	205.02	
IMMEDIATE TRANSFER SCORE	School	2	1505.17	4.79**
	Degree of Interaction	3	39.38	-
	IQ	1	28261.68	89.89**
	S x D	6	251.43	-
	S x I	2	66.03	-
	D x I	3	244.14	-
	S x D x I	6	215.82	-
	Within Replicates	142	314.41	

** significant beyond the .01 level

Table 7-B

Summary Means and S.D.'s of Percentage Scores on IMMEDIATE PROFICIENCY Test (N = 166)

Levels of Independent Variables		Mean	S.D.	Sign. Level
SCHOOL	School A	88.32	12.50	< .01
	School B	82.29	17.47	
	School C	79.40	19.37	
DEGREE OF INTERACTION	Condition #1	84.17	18.15	N.S.
	Condition #2	83.70	18.18	
	Condition #3	83.72	14.41	
	Control	82.16	17.21	
IQ	High	92.15	8.32	< .01
	Low	74.70	18.79	

Table 8-B

Summary Means and S.D.'s of Percentage Scores on IMMEDIATE TRANSFER Test (N = 166)

Levels of Independent Variables		Mean	S.D.	Sign. Level
SCHOOL	School A	64.58	22.36	< .01
	School B	62.53	20.96	
	School C	54.41	21.92	
DEGREE OF INTERACTION	Condition #1	60.08	23.96	N.S.
	Condition #2	62.34	21.92	
	Condition #3	60.41	20.16	
	Control	59.79	23.09	
IQ	High	73.58	15.38	< .01
	Low	47.54	20.05	

Table 9-B

Summaries of Analyses of Variance of DELAYED PROFICIENCY and TRANSFER Scores
(3 x 4 x 2 Design)

	Source	D.F.	Mean Squares	F
DELAYED PROFICIENCY SCORE	School	2	1744.20	8.33**
	Degree of Interaction	3	80.89	-
	IQ	1	15643.47	74.72**
	S x D	6	140.33	-
	S x I	2	395.05	1.89
	D x I	3	140.01	-
	S x D x I	6	135.50	-
	Within Replicates	142	209.36	
DELAYED TRANSFER SCORE	School	2	1843.68	6.17**
	Degree of Interaction	3	114.25	-
	IQ	1	33758.95	112.92**
	S x D	6	619.06	2.07
	S x I	2	82.51	-
	D x I	3	864.25	2.89*
	S x D x I	6	189.22	-
	Within Replicates	142	298.95	

* significant beyond the .05 level

** significant beyond the .01 level

Table 10-B

Summary Means and S.D.'s of Percentage Scores on DELAYED PROFICIENCY Test
(N = 166)

Levels of Independent Variables		Mean	S.D.	Sign. Level
SCHOOL	School A	87.12	14.10	< .01
	School B	81.74	17.65	
	School C	76.31	19.71	
DEGREE OF INTERACTION	Condition #1	83.35	18.78	N.S.
	Condition #2	82.55	17.61	
	Condition #3	80.88	16.01	
	Control	80.74	18.97	
IQ	High	91.31	8.37	< .01
	Low	72.37	19.46	

Table 11-B

Summary Means and S.D.'s of Percentage Scores on DELAYED TRANSFER Test (N = 166)

Levels of Independent Variables		Mean	S.D.	Sign. Level
SCHOOL	School A	67.23	20.60	< .01
	School B	61.43	22.24	
	School C	55.69	24.74	
DEGREE OF INTERACTION	Condition #1	61.00	26.43	N.S.
	Condition #2	64.00	19.62	
	Condition #3	60.89	20.70	
	Control	60.62	25.42	
IQ	High	75.49	14.92	< .01
	Low	47.55	20.89	

Table 12-B

Summary of Analysis of Variance of ERROR RATES During the Program (3 x 4 x 2 Design)

	Source	D.F.	Mean Squares	F
ERROR RATES	School	2	292.91	5.98**
	Degree of Interaction	3	27.86	-
	IQ	1	2807.92	57.36**
	S x D	6	61.22	1.25
	S x I	2	129.29	2.64
	D x I	3	32.83	-
	S x D x I	6	36.93	-
	Within Replicates	142	48.96	

Table 13-B

Summary Means and S.D.'s of ERROR RATES (N = 166)

Levels of Independent Variables		Mean	S.D.	Sign. Level
SCHOOL	School A	6.80	7.07	< .01
	School B	10.80	10.53	
	School C	8.55	5.94	
DEGREE OF INTERACTION	Condition #1	9.42	8.41	N.S.
	Condition #2	7.61	7.11	
	Condition #3	9.29	6.98	
	Control	8.23	10.83	
IQ	High	4.74	3.51	< .01
	Low	12.71	9.61	

Table 14-B

Summaries of Analyses of Variance of POST-EXPERIMENTAL ATTITUDES Toward CONTENT and METHODS of Instruction
(3 x 4 x 2 Design)

	Source	D.F.	Mean Squares	F
POST-EXPERIMENTAL CONTENT ATTITUDE SCORE	School	2	1610.04	4.19*
	Degree of Interaction	3	177.68	-
	IQ	1	330.66	-
	S x D	6	821.68	2.14
	S x I	2	122.90	-
	D x I	3	159.55	-
	S x D x I	6	475.20	1.24
	Within Replicates	142	384.07	
POST-EXPERIMENTAL METHODS ATTITUDE SCORE	School	2	5523.29	9.68**
	Degree of Interaction	3	843.46	1.48
	IQ	1	.22	-
	S x D	6	797.12	1.40
	S x I	2	87.02	-
	D x I	3	320.79	-
	S x D x I	6	372.21	-
	Within Replicates	142	570.66	

* significant beyond the .05 level

** significant beyond the .01 level

Table 15-B

Summary Means and S.D.'s of POST-EXPERIMENTAL Scores on CONTENT ATTITUDE Scales

(N = 166)

Levels of Independent Variables		Mean	S.D.	Sign. Level
SCHOOL	School A	37.47	20.72	<.05
	School B	38.95	20.26	
	School C	47.48	18.62	
DEGREE OF INTERACTION	Condition #1	41.20	20.04	N.S.
	Condition #2	40.64	21.91	
	Condition #3	38.80	20.15	
	Control	44.88	18.81	
IQ	High	42.48	17.50	N.S.
	Low	39.68	22.80	

Table 16-B

Summary Means and S.D.'s of POST-EXPERIMENTAL Scores METHODS ATTITUDE Scales
(N = 166)

	Levels of Independent Variables	Mean	S.D.	Sign. Level
SCHOOL	School A	40.69	25.60	< .01
	School B	46.49	26.12	
	School C	60.90	18.20	
DEGREE OF INTERACTION	Condition #1	48.68	22.33	N.S.
	Condition #2	54.98	22.81	
	Condition #3	45.83	29.06	
	Control	45.50	24.94	
IQ	High	48.89	24.53	N.S.
	Low	49.00	25.72	

Table 17-B

Summaries of Analyses of Variance of IMMEDIATE PROFICIENCY and TRANSFER Scores
(3 x 3 x 2 x 2 Design)

	Source	D.F.	Mean Squares	F
IMMEDIATE PROFICIENCY SCORE	School	2	1036.48	4.74*
	Degree of Interaction	2	25.55	-
	IQ	1	10084.96	46.07**
	Group Similarity	1	164.26	-
	S x D	4	101.23	-
	S x I	2	468.20	2.14
	S x GS	2	180.51	-
	D x I	2	113.78	-
	D x GS	2	111.05	-
	I x GS	1	101.05	-
	S x D x I	4	101.94	-
	S x D x GS	4	408.89	1.87
	S x I x GS	2	70.77	-
	D x I x GS	2	64.99	-
	S x D x I x GS	4	82.11	-
	Within Replicates	98	218.89	
IMMEDIATE TRANSFER SCORE	School	2	2166.57	7.16**
	Degree of Interaction	2	85.04	-
	IQ	1	20988.47	69.38**
	Group Similarity	1	196.93	-
	S x D	4	81.77	-
	S x I	2	47.19	-
	S x GS	2	231.05	-
	D x I	2	261.07	-
	D x GS	2	1483.03	4.90**
	I x GS	1	142.86	-
	S x D x I	4	351.69	1.16
	S x D x GS	4	309.84	1.02
	S x I x GS	2	200.32	-
	D x I x GS	2	58.10	-
	S x D x I x GS	4	275.07	-
	Within Replicates	98	302.50	

* significant beyond the .05 level

** significant beyond the .01 level

Table 18-B

Summary Means and S.D.'s of Percentage Scores on IMMEDIATE PROFICIENCY Test (N = 134)

Levels of Independent Variables		Mean	S.D.	Sign. Level
SCHOOL	School A	88.32	13.66	<.05
	School B	82.67	16.26	
	School C	79.67	19.34	
DEGREE OF INTERACTION	Condition #1	84.17	18.15	N.S.
	Condition #2	83.40	17.99	
	Condition #3	83.07	14.60	
		91.97	8.78	<.01
		74.59	18.69	
GROUP SIMILARITY	Homogeneous	84.88	13.85	N.S.
	Heterogeneous	82.23	19.31	

Table 19-B

Summary Means and S.D.'s of Percentage Scores on IMMEDIATE TRANSFER Test (N = 134)

Levels of Independent Variables		Mean	S.D.	Sign. Level
SCHOOL	School A	66.08	22.01	<.01
	School B	63.38	20.64	
	School C	53.23	21.42	
DEGREE OF INTERACTION	Condition #1	60.08	23.96	N.S.
	Condition #2	62.34	21.92	
	Condition #3	60.41	20.16	
		73.07	16.15	<.01
		48.06	19.80	
GROUP SIMILARITY	Homogeneous	62.26	20.64	N.S.
	Heterogeneous	59.65	23.14	

Table 20-B

Summaries of Analyses of Variance of DELAYED PROFICIENCY and TRANSFER Scores (3 x 3 x 2 x 2 Design)

	Source	D.F.	Mean Squares	F
DELAYED PROFICIENCY SCORE	School	2	2016.70	9.26**
	Degree of Interaction	2	65.16	-
	IQ	1	11281.16	51.81**
	Group Similarity	1	3.05	-
	S x D	4	106.73	-
	S x I	2	460.95	2.12
	S x GS	2	177.25	-
	D x I	2	40.84	-
	D x GS	2	48.38	-
	I x GS	1	.06	-
	S x D x I	4	200.43	-
	S x D x GS	4	451.42	2.07
	S x I x GS	2	203.95	-
	D x I x GS	2	14.45	-
	S x D x I x GS	4	55.20	-
	Within Replicates	98	217.74	
DELAYED TRANSFER SCORE	School	2	2926.61	9.67**
	Degree of Interaction	2	57.53	-
	IQ	1	22399.21	73.98**
	Group Similarity	1	55.47	-
	S x D	4	42.93	-
	S x I	2	219.22	-
	S x GS	2	55.29	-
	D x I	2	598.21	1.98
	D x GS	2	815.71	2.69
	I x GS	1	18.57	-
	S x D x I	4	118.63	-
	S x D x GS	4	461.68	1.53
	S x I x GS	2	312.67	1.03
	D x I x GS	2	95.16	-
	S x D x I x GS	4	131.47	-
	Within Replicates	98	302.79	

** significant beyond the .01 level

Table 21-B

Summary Means and S.D.'s of Percentage Scores on DELAYED PROFICIENCY Test

(N = 134)

Levels of Independent Variables		Mean	S.D.	Sign. Level
SCHOOL	School A	88.21	13.67	<.01
	School B	82.48	16.41	
	School C	75.85	19.66	
DEGREE OF INTERACTION	Condition #1	83.19	18.77	N.S.
	Condition #2	82.55	17.61	
	Condition #3	80.88	16.01	
IQ	High	90.99	8.67	<.01
	Low	72.84	19.37	
GROUP SIMILARITY	Homogeneous	82.61	15.61	N.S.
	Heterogeneous	81.78	19.04	

Table 22-B

Summary Means and S.D.'s of Percentage
Scores on DELAYED TRANSFER Test
(N = 134)

Levels of Independent Variables		Mean	S.D.	Sign. Level
SCHOOL	School A	67.98	19.98	<.01
	School B	63.65	20.54	
	School C	52.76	23.39	
DEGREE OF INTERACTION	Condition #1	60.83	25.47	N.S.
	Condition #2	62.78	20.40	
	Condition #3	60.91	20.64	
IQ	High	74.18	15.14	<.01
	Low	48.03	20.39	
GROUP SIMILARITY	Homogeneous	62.49	20.45	N.S.
	Heterogeneous	60.53	23.74	

Table 23-B

Summary of Analysis of Variance of
ERROR RATES During the Program
(3 x 3 x 2 x 2 Design)

	Source	D.F.	Mean Squares	F
ERROR RATE	School	2	129.18	3.28*
	Degree of Interaction	2	52.83	1.34
	IQ	1	1996.96	50.62**
	Group Similarity	1	38.64	-
	S x D	4	43.45	1.10
	S x I	2	70.93	1.80
	S x GS	2	73.36	1.86
	D x I	2	37.61	-
	D x GS	2	5.11	-
	I x GS	1	118.31	3.00
	S x D x I	4	16.35	-
	S x D x GS	4	103.51	2.62
	S x I x GS	2	27.62	-
	D x I x GS	2	7.35	-
	S x D x I x GS	4	32.92	-
	Within Replicates	98	39.45	

* significant beyond the .05 level

** significant beyond the .01 level

Table 24-B

Summary Means and S.D.'s of ERROR RATES
(N = 134)

Levels of Independent Variables		Mean	S.D.	Sign. Level
SCHOOL	School A	7.38	7.71	< .05
	School B	10.36	8.62	
	School C	8.53	5.68	
DEGREE OF INTERACTION	Condition #1	9.42	8.41	N.S.
	Condition #2	7.61	7.11	
	Condition #3	9.29	6.98	
IQ	High	4.94	3.74	< .01
	Low	12.87	8.33	
GROUP SIMILARITY	Homogeneous	8.31	5.44	N.S.
	Heterogeneous	9.25	9.10	

Table 25-B

Summaries of Analyses of Variance of POST-EXPERIMENTAL ATTITUDES Toward CONTENT and METHODS of Instruction
(3 x 3 x 2 x 2 Design)

	Source	D.F.	Mean Squares	F
POST-EXPERIMENTAL CONTENT ATTITUDE SCORE	School	2	2134.88	5.56**
	Degree of Interaction	2	144.97	-
	IQ	1	503.55	1.31
	Group Similarity	1	32.14	-
	S x D	4	917.14	2.39
	S x I	2	120.69	-
	S x GS	2	285.75	-
	D x I	2	181.13	-
	D x GS	2	19.94	-
	I x GS	1	2491.51	6.48*
	S x D x I	4	256.36	-
	S x D x GS	4	936.46	2.44
	S x I x GS	2	309.80	-
	D x I x GS	2	815.89	2.12
	S x D x I x GS	4	207.41	-
	Within Replicates	98	384.32	
POST-EXPERIMENTAL METHODS ATTITUDE SCORE	School	2	5065.81	8.74**
	Degree of Interaction	2	1038.16	1.79
	IQ	1	5.98	-
	Group Similarity	1	78.15	-
	S x D	4	569.59	-
	S x I	2	311.59	-
	S x GS	2	565.14	-
	D x I	2	604.36	1.04
	D x GS	2	15.32	-
	I x GS	1	716.76	1.24
	S x D x I	4	375.01	-
	S x D x GS	4	178.22	-
	S x I x GS	2	261.50	-
	D x I x GS	2	516.25	-
	S x D x I x GS	4	878.16	1.52
	Within Replicates	98	579.57	

* significant beyond the .05 level

** significant beyond the .01 level

Table 26-B

Summary Means and S.D.'s of POST-EXPERIMENTAL Scores on CONTENT ATTITUDE Scales (N = 134)

Levels of Independent Variables		Mean	S.D.	Sign. Level
SCHOOL	School A	33.84	19.35	<.01
	School B	39.41	20.90	
	School C	47.36	19.59	
DEGREE OF INTERACTION	Condition #1	41.20	20.04	N.S.
	Condition #2	40.64	21.91	
	Condition #3	38.80	20.15	
IQ	High	42.33	18.38	N.S.
	Low	37.92	22.61	
GROUP SIMILARITY	Homogeneous	40.73	22.25	N.S.
	Heterogeneous	39.68	18.97	

Table 27-B

Summary Means and S.D.'s of POST-EXPERIMENTAL Scores on METHODS ATTITUDE Scales (N = 134)

Levels of Independent Variables		Mean	S.D.	Sign. Level
SCHOOL	School A	38.80	24.92	<.01
	School B	49.02	25.69	
	School C	61.52	19.27	
DEGREE OF INTERACTION	Condition #1	48.68	22.33	N.S.
	Condition #2	54.98	22.81	
	Condition #3	45.83	29.06	
IQ	High	49.96	25.12	N.S.
	Low	49.57	25.27	
GROUP SIMILARITY	Homogeneous	49.29	24.48	N.S.
	Heterogeneous	50.24	25.85	

Table 28-B

Summaries of Analyses of Variance of the Number of Frames on Which INFORMATION SEEKING and PROVIDING RESPONSES, and any DISCUSSION Occurred During Condition #3 (3 x 2 x 2 Design)

	Source	D.F.	Mean Squares	F
INFORMATION SEEKING RESPONSES	School	2	582.80	2.52
	IQ	1	848.43	3.66
	Group Similarity	1	30.54	-
	S x I	2	98.90	-
	S x GS	2	322.97	1.39
	I x GS	1	100.43	-
	S x I x GS	2	342.63	1.48
	Within Replicates	34	231.69	
INFORMATION PROVIDING RESPONSES	School	2	1140.13	1.39
	IQ	1	1047.11	1.27
	Group Similarity	1	133.79	-
	S x I	2	648.04	-
	S x GS	2	1184.00	1.44
	I x GS	1	2648.69	3.22
	S x I x GS	2	205.56	-
	Within Replicates	34	821.65	
ALL DISCUSSION	School	2	10486.27	8.61**
	IQ	1	1796.11	1.47
	Group Similarity	1	2367.37	1.94
	S x I	2	2833.51	2.33
	S x GS	2	8515.56	6.99**
	I x GS	1	10184.27	8.36**
	S x I x GS	2	4419.17	3.63*
	Within Replicates	34	1218.42	

* significant beyond the .05 level

** significant beyond the .01 level

Table 29-B

Summary Means and S.D.'s of INFORMATION-SEEKING RESPONSES During Condition #3
(N = 46)

Levels of Independent Variables		Mean	S.D.	Sign. Level
SCHOOL	School A	10.53	11.73	N.S.
	School B	15.27	17.17	
	School C	22.88	16.70	
IQ	High	12.25	11.55	N.S.
	Low	20.86	18.93	
GROUP SIMILARITY	Homogeneous	15.75	13.82	N.S.
	Heterogeneous	17.05	18.30	

Table 30-B

Summary Means and S.D.'s of INFORMATION-PROVIDING RESPONSES During Condition #3
(N = 46)

Levels of Independent Variables		Mean	S.D.	Sign. Level
SCHOOL	School A	27.47	26.11	N.S.
	School B	23.87	17.48	
	School C	39.50	38.22	
IQ	High	34.42	32.80	N.S.
	Low	26.18	24.21	
GROUP SIMILARITY	Homogeneous	31.33	23.28	N.S.
	Heterogeneous	29.55	34.73	

Table 31-B

Summary Means and S.D.'s of ALL DISCUSSION During Condition #3
(N = 46)

Levels of Independent Variables		Mean	S.D.	Sign. Level
SCHOOL	School A	74.47	61.60	$<.01$
	School B	52.87	25.36	
	School C	105.12	41.22	
IQ	High	70.33	44.45	N.S.
	Low	86.55	53.72	
GROUP SIMILARITY	Homogeneous	83.83	48.99	N.S.
	Heterogeneous	71.82	49.85	